Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609-2000

April 28, 2005

10 CFR 50, APPENDIX I,
Sections IV.B.2, IV.B.3, & IV.C

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - UNITS 1, 2, AND 3 - ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR) REPORT - JANUARY THROUGH DECEMBER 2004

In accordance with the BFN Technical Specifications (TS) Section 5.6.2 and 10 CFR 50, Appendix I, Section IV.B, TVA is submitting the AREOR report for BFN Units 1, 2, and 3. This report covers the period from January through December 2004.

TS Section 5.6.2 requires that the enclosed AREOR report contain summaries, interpretations, and analyses of trends of the results of the Radiological Environmental Monitoring Program for the reporting period. In addition, the BFN Offsite Dose Calculation Manual, Section 5.1, requires the AREOR include the following information:

- Results of land use censuses
- Summarized and tabulated results of the radiological environmental samples taken during the reporting period, in the format of Regulatory Guide 4.8, December 1975, and NUREG 1302, April 1991
- Summary description of the radiological environmental monitoring program

IE25

- A map of sampling locations keyed to a table giving distances and directions from one reactor

- Results of TVA's participation in the Interlaboratory Comparison Program

The report concludes that based upon the analysis of the environmental sampling results and trend data, the exposure to members of the public which may have been attributable to BFN operation is negligible.

There are no regulatory commitments contained in this letter. If you have any questions, please contact me at (256) 729-2636.

Sincerely,

T. E. Abney
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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT
UNITS 1, 2, AND 3

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT (AREOR),
JANUARY THROUGH DECEMBER 2004

(See Attached)

Annual Radiological Environmental Operating Report

Browns Ferry Nuclear Plant 2004

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

BROWNS FERRY NUCLEAR PLANT

2004

TENNESSEE VALLEY AUTHORITY

April 2005

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EXECUTIVE SUMMARY

This report describes the radiological environmental monitoring program conducted by TVA in the vicinity of the Browns Ferry Nuclear Plant (BFN) in 2004. The program includes the collection of samples from the environment and the determination of the concentrations of radioactive materials in the samples. Samples are taken from stations in the general area of the plant and from areas not influenced by plant operations. Monitoring includes the sampling of air, water, soil, food crops, fish, shoreline sediment, and the measurement of direct radiation levels. Results from stations near the plant food crops are compared with concentrations from control stations and with preoperational measurements to determine potential impacts of plant operations.

The vast majority of the activity detected from environmental samples was the result of naturally occurring radioactive materials. Small amounts of Cs-137 were measured in a limited number of samples collected during 2004. The concentrations measured for Cs-137 were consistent with levels commonly found in the environment as a result of atmospheric nuclear weapons fallout. The level of activity measured in these samples would result in no measurable increase over background in the dose to the general public.

INTRODUCTION

This report describes and summarizes results of radioactivity measurements made in the vicinity of BFN and laboratory analyses of samples collected in the area. The measurements are made to comply with the requirements of 10 CFR 50, Appendix A, Criterion 64 and 10 CFR 50, Appendix I, Sections IV.B.2, IV.B.3 and IV.C and to determine potential effects on public heath and safety. This report satisfies the annual reporting requirements of BFN Technical Specification 5.6.2 and Offsite Dose Calculation Manual (ODCM) Administrative Control 5.1. The data presented in this report include results from the prescribed program and information to help correlate the significance of results measured by this monitoring program to the levels of environmental radiation resulting from naturally occurring radioactive materials.

Naturally Occurring and Background Radioactivity

Most materials in our world today contain trace amounts of naturally occurring radioactivity. Potassium-40 (K-40), with a half-life of 1.3 billion years, is one of the major types of radioactive materials found naturally in our environment. An individual weighing 150 pounds contains about 140 grams of potassium (Reference 1). This is equivalent to approximately 100,000 pCi of K-40 which delivers a dose of 15 to 20 mrem per year to the bone and soft tissue of the body. Other examples of naturally occurring radioactive materials are beryllium (Be)-7, bismuth (Bi)-212, 214, lead (Pb)-212, 214, thallium (Tl)-208, actinium (Ac)-228, uranium (U)-238, 235, thorium (Th)-234, radium (Ra)-226, radon (Rn)-222, carbon (C)-14, and hydrogen (H)-3 (generally called tritium). The radiation from these materials makes up a part of the low-level natural background radiation. The remainder of the natural background radiation comes in the form of cosmic ray radiation from outer space.

It is possible to get an idea of the relative hazard of different types of radiation sources by evaluating the amount of radiation the U.S. population receives from each general type of radiation source. The following information is primarily adapted from References 2 and 3.

U.S. GENERAL POPULATION AVERAGE DOSE EQUIVALENT ESTIMATES

Source	Millirem/Year Per Person
Natural background dose equivalent	
Cosmic	27
Cosmogenic	1
Terrestrial	28
In the body	39
Radon-222	200
Total	295
Release of radioactive material in natural gas, mining, ore processing, etc.	5
Medical (effective dose equivalent)	53
Nuclear weapons fallout	less than 1
Nuclear energy	0.28
Consumer products	0.03
Total	355 (approximately)

As can be seen from the table, the natural background radiation dose equivalent to the U.S. population normally exceeds that from nuclear plants by several hundred times. This indicates that nuclear plant operations normally result in a population radiation dose equivalent which is insignificant compared to that which results from natural background radiation. It should be noted that the use of radiation and radioactive materials for medical uses has resulted in a similar effective dose equivalent to the U.S. population as that caused by natural background cosmic and terrestrial radiation.

Electric Power Production

Nuclear power plants are similar in many respects to conventional coal burning (or other fossil fuel) electrical generating plants. The basic process behind electrical power production in both types of plants is that fuel is used to heat water to produce steam which provides the force to turn turbines and generators. In a nuclear power plant, the fuel is uranium and heat is produced in the reactor through the fission of the uranium. Nuclear plants include many complex systems to control the nuclear fission process and to safeguard against the possibility of reactor malfunction. The nuclear reactions produce radionuclides commonly referred to as fission and activation products. Very small amounts of these fission and activation products are released into the plant systems. This radioactive material can be transported throughout plant systems and some of it released to the environment.

The pathways through which radioactivity is released are monitored. Liquid and gaseous effluent monitors record the radiation levels for each release. These monitors also provide alarm mechanisms to prompt termination of any release above limits.

Releases are monitored at the onsite points of release and through the environmental monitoring program which measures the environmental radiation in areas around the plant. In this way, not only is the release of radioactive materials from the plant tightly controlled, but measurements are made in surrounding areas to verify that the population is not being exposed to significant levels of radiation or radioactive materials.

The BFN ODCM, which is required by the plant Technical Specifications, prescribes limits for the release of radioactive effluents, as well as limits for doses to the general public from the release of these effluents. The dose to a member of the general public from radioactive materials released to unrestricted areas, as given in NRC guidelines and in the ODCM, is limited as follows:

Liquid Effluents

Total body	≤3 mrem/year
Any organ	≤10 mrem/year

Gaseous Effluents

Noble gases:

Gamma radiation	≤10 mrad/year
Beta radiation	≤20 mrad/year

Particulates:

Any organ	≤15 mrem/year

The Environmental Protection Agency (EPA) limits for the total dose to the public in the vicinity of a nuclear power plant, established in the Environmental Dose Standard of 40 CFR 190, are as follows:

Total body	≤25 mrem/year
Thyroid	≤75 mrem/year
Any other organ	≤25 mrem/year

Appendix B to 10 CFR 20 presents the regulatory limits for the annual average concentrations of radioactive materials released in gaseous and liquid effluents at the boundary of the unrestricted area. Table 1 of this report compares the nominal lower limits of detection for the BFN monitoring program with the regulatory limits for maximum annual average effluent concentrations released to unrestricted areas and levels requiring special reports to the NRC. The data presented in this report indicate compliance with the regulations.

SITE/PLANT DESCRIPTION

Browns Ferry Nuclear Plant (BFN) is located on the north shore of Wheeler Reservoir at Tennessee River Mile 294 in Limestone County in north Alabama (Figure 1). Wheeler Reservoir averages 1 to 1-1/2 miles in width in the vicinity of the plant. The site, containing approximately 840 acres, is approximately 10 miles southwest of Athens, Alabama, and 10 miles northwest of Decatur, Alabama. The dominant character of land use is small, scattered villages and homes in an agricultural area. A number of relatively large farming operations occupy much of the land on the north side of the river immediately surrounding the plant. The principal crop grown in the area is cotton.

Approximately 2500 people live within a 5-mile radius of the plant. The town of Athens has a population of about 17,000, while approximately 49,000 people live in the city of Decatur. The largest city in the area with approximately 160,000 people is Huntsville, Alabama, located about 24 miles east of the site.

Area recreation facilities are developed along the Tennessee River. The nearest facilities are public use areas located 2 to 3 miles from the site. The city of Decatur has developed a large municipal recreation area, Point Mallard Park, approximately 15 miles upstream of the site. The Tennessee River is also a popular sport fishing area.

BFN consists of three boiling water reactors. Unit 1 achieved criticality on August 17, 1973, and began commercial operation on August 1, 1974. Unit 2 began commercial operation on March 1, 1975. However, a fire in the cable trays on March 22, 1975, forced the shutdown of both reactors. Units 1 and 2 resumed operation and Unit 3 began testing in August 1976. Unit 3 began commercial operation in March 1977.

All three units were out of service from March 1985 to May 1991. Unit 2 was restarted May 24, 1991 and Unit 3 restarted on November 19, 1995. Recovery work for Unit 1 is ongoing.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Most of the radiation and radioactivity generated in a nuclear power reactor is contained within the reactor itself or one of the other plant systems. Plant effluent monitors are designed to detect the small amounts released to the environment. Environmental monitoring is a final verification that the systems are performing as planned. The monitoring program is designed to sample the pathways between the plant and the people in the immediate vicinity of the plant. Sample types are chosen so that the potential for detection of radioactivity in the environment will be maximized. The radiological environmental monitoring program is outlined in Appendix A.

There are two primary pathways by which radioactivity can move through the environment to humans: air and water (see Figure 2). The air pathway can be separated into two components: the direct (airborne) pathway and the indirect (ground or terrestrial) pathway. The direct airborne pathway consists of direct radiation and inhalation by humans. In the terrestrial pathway, radioactive materials may be deposited on the ground or on plants and subsequently be ingested by animals and/or humans. Human exposure through the liquid pathway may result from drinking water, eating fish, or by direct exposure at the shoreline. The types of samples collected in this program are designed to monitor these pathways

A number of factors were considered in determining the locations for collecting environmental samples. The locations for the atmospheric monitoring stations were determined from a critical pathway analysis based on weather patterns, dose projections, population distribution, and land use. Terrestrial sampling stations were selected after reviewing such things as the locations of dairy animals and gardens in conjunction with the air pathway analysis. Liquid pathway stations were selected based on dose projections, water use information, and availability of media such as fish and sediment. Table A-2 (Appendix A, Table 2: This method of notation is used for all tables and figures given in the appendices.) lists the sampling stations and the types of samples collected from each.

Modifications made to the REMP program are described in Appendix B. While there were no modifications made in 2004, Appendix B is included in this report as a place keeper. Deviations in the sampling and analysis schedule are discussed in Appendix C.

To determine the amount of radioactivity in the environment prior to the operation of BFN, a preoperational radiological environmental monitoring program was initiated in 1968 and operated until the plant began operation in 1973. Sampling and analyses conducted during the preoperational phase has provided data that can be used to establish normal background levels for various radionuclides in the environment.

The preoperational monitoring program is a very important part of the overall program. During the 1950s, 60s, and 70s, atmospheric nuclear weapons testing released radioactive material to the environment causing fluctuations in background radiation levels. This radioactive material is the same type as that produced in the BFN reactors. Preoperational knowledge of radionuclide patterns in the environment permits a determination, through comparison and trending analyses, of whether the operation of BFN is impacting the environment and thus the surrounding population.

The evaluation of the impact of plant operations also utilizes data from control stations that have been established in the monitoring program. Results of environmental samples taken at control stations (far from the plant) are compared with those from indicator stations (near the plant) to establish the extent of BFN influence.

Sample analyses are performed by TVA's Environmental Radiological Monitoring and Instrumentation (ERM&I) group located at the Western Area Radiological Laboratory (WARL) in Muscle Shoals, Alabama. The analyses are conducted in accordance with written and approved procedures and are based on accepted methods. A summary of the analysis techniques and methodology is presented in Appendix D. Data tables summarizing the sample analysis results are presented in Appendix H.

The radiation detection devices and analysis methods used to determine the radionuclide content of samples collected in the environment are very sensitive to small amounts of radioactivity. The sensitivity of the measurement process is defined in terms of the lower limit of detection (LLD). A description of the nominal LLDs for the Radioanalytical Laboratory is presented in Appendix E.

The ERM&I Laboratory applies a comprehensive quality assurance/quality control program to monitor laboratory performance throughout the year. The program is intended to detect any problems in the measurement process as soon as possible so they can be corrected. This program includes instrument checks to ensure that the radiation detection instruments are working properly and the analysis of quality control samples. To provide for interlaboratory comparison program cross checks, the laboratory participated in a blind sample program administrated by Analytics, Incorporated. In addition, samples are split with the EPA National Air and Radiation Environmental Laboratory and the State of Alabama. A complete description of the quality control program is presented in Appendix F.

DIRECT RADIATION MONITORING

Direct radiation levels are measured at a number of stations around the plant site. These measurements include contributions from cosmic radiation, radioactivity in the ground, fallout from atmospheric nuclear weapons tests conducted in the past, and radioactivity that may be present as a result of plant operations. Because of the relative large variations in background radiation as compared to the small levels from the plant, contributions from the plant are difficult to distinguish.

Radiation levels measured in the area around the BFN site in 2004 were consistent with levels from previous years and with levels measured at other locations in the region.

Measurement Techniques

Direct radiation measurements are made with thermoluminescent dosimeters (TLDs). TVA uses the Panasonic Model UD-814 dosimeter for measurement of the environmental radiation levels. This dosimeter contains four elements consisting of one lithium borate and three calcium sulfate phosphors. The calcium sulfate phosphors are shielded by approximately 1000 mg/cm^2 plastic and lead to compensate for the over-response of the detector to low energy radiation.

TLDs are placed approximately 1 meter above the ground, with two or more TLDs at each monitoring location. Monitoring points for TLDs are located in each of the sixteen compass sectors surrounding the site. One monitoring point is located in each sector near the site boundary and a second monitoring point is located at a distance of approximately five miles in each sector. Nine additional locations are distributed through the sectors out to a distance of approximately 32 miles. The TLDs are exchanged every 3 months and read with a Panasonic Model UD-710A automatic reader interfaced with a computer system for analysis of the data.

Since the calcium sulfate phosphor is much more sensitive than the lithium borate, the measured exposure is taken as the median of the results obtained from the calcium sulfate phosphors in all detectors from the monitoring location. The values are corrected for gamma response, system variations, and transit exposure, with individual gamma response calibrations for each element. The system meets or exceeds the performance specifications outlined in Regulatory Guide 4.13 for environmental applications of TLDs.

Results

All results are normalized to a standard quarter (91.25 days or 2190 hours). The monitoring locations are grouped according to the distance from the plant. The first group consists of all locations within 1 mile of the plant. The second group lies between 1 and 2 miles, the third group between 2 and 4 miles, the fourth between 4 and 6 miles, and the fifth group is made up of all locations more than 6 miles from the plant. Past data have shown that the results from all monitoring points greater than 2 miles from the plant are essentially the same. Therefore, for purposes of this report, all locations 2 miles or less from the plant are identified as "onsite" stations and all others are considered "offsite."

The quarterly gamma radiation levels determined from the TLDs deployed around BFN in 2004 are summarized in Table H-1. The results from all measurements at individual locations are presented in Table H-2. The exposures are measured in milliroentgens. For purposes of this report, one milliroentgen (mR), one millirem (mrem), and one millirad are assumed to be numerically equivalent. The rounded average annual exposures are shown below.

Annual Average
Direct Radiation Levels

	mR/Year BFN 2004
Onsite Stations	68
Offsite Stations	59

The data in Table H-1 indicate that the average quarterly radiation levels at the BFN onsite locations are approximately 2.3 mR/quarter higher than levels at the offsite locations. This difference is consistent with levels measured for preoperation and construction phases of TVA nuclear plant sites where the average radiation levels on site were generally 2-6 mR/quarter higher than the levels offsite. The causes of these differences have not been isolated; however, it is postulated that the differences are probably attributable to combinations of influences such as natural variations in environmental radiation levels, earth-moving activities onsite, and the mass of concrete employed in the construction of the plant. Other undetermined influences may also play a part.

Figure H-1 compares plots of the environmental gamma radiation levels from the onsite or site boundary locations with those from the offsite locations over the period from 1976 through 2004.

All results reported in 2004 are consistent with direct radiation levels identified at locations which are not influenced by the operation of BFN. There is no indication that BFN activities increased the background direct radiation levels normally observed in the areas surrounding the plant.

ATMOSPHERIC MONITORING

The atmospheric monitoring network is divided into three groups identified as local, perimeter, and remote. In the current program, five local air monitoring stations are located on or adjacent to the plant site in the general direction of greatest wind frequency. Three of these stations (LM-1, LM-2, and LM-3) are located on the plant side of the Tennessee River and two stations (LM-6 and LM-7) are located immediately across the river from the plant site. One additional station (station LM-4) is located at the point of maximum predicted offsite concentration of radionuclides based on meteorological data. Three perimeter air monitoring stations are located in communities out to about 13 miles from the plant, and two monitors used as controls are located out to 32 miles. The monitoring program and the locations of monitoring stations are identified in the tables and figures of Appendix A.

Results from the analysis of samples in the atmospheric pathway are presented in Tables H-3 and H-4. Radioactivity levels identified in this reporting period are consistent with background radioactivity levels.

Sample Collection and Analysis

Air particulates are collected by continuously sampling air at a flow rate of approximately 2 cubic feet per minute (cfm) through a 2-inch glass fiber filter. The sampling system consists of a pump, a magnehelic gauge for measuring the drop in pressure across the system, and a dry gas meter. This allows an accurate determination of the volume of air passing through the filter. The sampling system is housed in a metal building. The filter is contained in a sampling head mounted on the outside of the monitor building. The filter is replaced weekly. Each filter is analyzed for gross beta activity about 3 days after collection to allow time for the radon daughters to decay. Every 4 weeks, composites of the filters from each location are analyzed by gamma spectroscopy.

Gaseous radioiodine is collected using a commercially available cartridge containing TEDA-impregnated charcoal. This system is designed to collect iodine in both the elemental form and as organic compounds. The cartridge is located in the same sampling head as the air particulate filter and is downstream of the particulate filter. The cartridge is changed at the same time as the particulate filter and samples the same volume of air. Each cartridge is analyzed for I-131 by gamma spectroscopy analysis.

Rainwater is sampled by use of a collection tray attached to the monitor building. As water drains from the tray, it is collected in one of two 5-gallon jugs inside the monitor building. A 1-gallon sample is removed from the container every 4 weeks. Any excess water is discarded. Rainwater samples are analyzed only if the air particulate samples indicate the presence of elevated activity levels or if fallout is expected. No rainwater samples from the vicinity of BFN were required to be analyzed in 2004.

Results

The results from the analysis of air particulate samples are summarized in Table H-3. Gross beta activity in 2004 was consistent with levels reported in previous years. The average gross beta concentrations in samples collected at both indicator and control locations was 0.020 pCi/m^3. The annual averages of the gross beta activity in air particulate filters at these stations for the years 1968-2004 are presented in Figure H-2. Increased levels due to fallout from atmospheric nuclear weapons testing are evident, especially in 1969, 1970, 1971, 1977, 1978, and 1981. Evidence of a small increase resulting from the Chernobyl accident can also be seen in 1986. These patterns are consistent with data from monitoring programs conducted by TVA at other nuclear power plant sites during construction and preoperational stages.

Only naturally occurring radionuclides were identified by the monthly gamma spectral analysis of the air particulate samples.

There was no I-131 detected in any charcoal cartridge samples collected during 2004. The results for the analysis of charcoal cartridges are reported in Table H-4.

TERRESTRIAL MONITORING

Terrestrial monitoring is accomplished by collecting samples of environmental media that may transport radioactive material from the atmosphere to humans. Samples of soil and food crops are collected and analyzed to determine the potential impacts from exposure to this pathway. The results from the analysis of these samples are shown in Tables H-5 through H-10.

A land use survey is conducted annually to locate milk producing animals and gardens within a 5-mile radius of the plant. No milk-producing animals have been identified within 5 miles of the plant. The results of the 2004 land use survey are presented in Appendix G.

Sample Collection and Analysis

Soil samples are collected annually from the air monitoring locations. The samples are collected with either a "cookie cutter" or an auger type sampler. After drying and grinding, the sample is analyzed by gamma spectroscopy. When the gamma analysis is complete, the sample is ashed and analyzed for Sr-89, 90.

Samples representative of food crops raised in the area near the plant are obtained from individual gardens, corner markets, or cooperatives. Types of foods may vary from year to year as a result of changes in the local vegetable gardens. In 2004, samples of apples, cabbage, corn, green beans, and tomatoes were collected from local gardens. The edible portion of each sample is analyzed by gamma spectroscopy.

Results

The only fission or activation product identified in soil samples was Cs-137. The average concentration measured in samples from indicator locations was 0.16 pCi/g. The average concentration for control locations was 0.11 pCi/g. These concentrations are consistent with levels previously reported from fallout. All other radionuclides reported were naturally occurring

isotopes. The results of the analysis of soil samples are reported in Table H-5. A plot of the annual average Cs-137 concentrations in soil is presented in Figure H-3. The concentration of Cs-137 in soil is steadily decreasing as a result of the cessation of weapons testing in the atmosphere, the 30-year half-life of Cs-137 and transport through the environment.

Only naturally occurring radioactivity was identified in food crops. The predominant natural radionuclide detected in samples of food crops was K-40. Analyses of these samples indicated no contribution from plant activities. The results are reported in Tables H-6 through H-10.

LIQUID PATHWAY MONITORING

Potential exposures from the liquid pathway can occur from drinking water, ingestion of fish, and from direct radiation exposure to radioactive materials deposited in the river shoreline sediment. The liquid pathway monitoring program conducted during 2004 included the collection of samples of surface (river/reservoir) water, groundwater, drinking water supplies, fish, and shoreline sediment. Samples from the reservoir are collected both upstream and downstream from the plant. BFN operated with zero releases of liquid radioactive effluents during 2004.

Results from the analysis of aquatic samples are presented in Tables H-11 through H-16. Radioactivity levels in water and shoreline sediment were consistent with background levels previously reported. Trace levels of Cs-137 were identified in fish.

Sample Collection and Analysis

Samples of surface water are collected from the Tennessee River using automatic sampling systems from one downstream station and one upstream station. The upstream sample is collected from the raw water intake at the Decatur, Alabama water plant and is utilized as control sampling location for both surface and drinking water. A timer turns on the system at least once every two hours. The line is flushed and a sample collected into a collection container. A 1-gallon sample is removed from the container every 4 weeks and the remaining water in the jug is discarded. The 4-week composite sample is analyzed by gamma spectroscopy and for gross beta activity. A quarterly composite sample is analyzed for tritium.

Samples are also collected by an automatic sampling system at the first downstream drinking water intake. This sample is collected at the intake for the water plant and is raw untreated water. These samples are collected in the same manner as the surface water samples.

These monthly samples are analyzed by gamma spectroscopy and for gross beta activity. A quarterly composite is analyzed for tritium.

At other selected locations, grab samples are collected from drinking water systems which use the Tennessee River as their source. These samples are analyzed every 4 weeks by gamma spectroscopy and for gross beta activity. A quarterly composite sample from each station is analyzed for tritium.

A groundwater well onsite is equipped with an automatic water sampler. Water is also collected from a private well in an area unaffected by BFN. Samples from the wells are collected every 4 weeks and analyzed by gamma spectroscopy. A quarterly composite sample is analyzed for tritium.

Samples of commercial and game fish species are collected semiannually from each of two reservoirs: the reservoir on which the plant is located (Wheeler Reservoir) and the upstream reservoir (Guntersville Reservoir). The samples are collected using a combination of netting techniques and electrofishing. To sample edible portions of the fish, the fish are filleted. After drying and grinding, the samples are analyzed by gamma spectroscopy.

Shoreline sediment was collected from two downstream recreational use areas and one upstream location. The samples were collected at the normal water level shoreline and analyzed by gamma spectroscopy.

Results

All radioactivity in surface water samples was below the detection limits except the gross beta activity and naturally occurring isotopes identified by gamma spectral analysis. These results are consistent with previously reported levels. A trend plot of the gross beta activity in surface water samples from 1968 through 2004 is presented in Figure H-4. A summary table of the results for this reporting period is shown in Table H-11.

For drinking water (public water), gross beta activity averaged 2.6 pCi/liter at the downstream stations and 2.3 pCi/liter at control stations. These results are consistent with previous monitoring results. The results are shown in Table H-12 and a trend plot of the gross beta activity from 1968 to 2004 is presented in Figure H-5.

No fission or activation products were detected in groundwater samples. Only naturally occurring radon decay products (Pb-214 and Bi-214) were identified in these samples. Results from the analysis of groundwater samples are presented in Table H-13.

Cesium-137 was identified in two samples of fish collected from the control location. The highest concentration measured was 0.03 pCi/g. This concentration was consistent with data from previous monitoring years. The only other isotopes found in fish were naturally occurring radionuclides. The results are summarized in Tables H-14 and H-15. Plots of the annual average Cs-137 concentrations in game fish are presented in Figure H-6.

Only naturally occurring radionuclides were identified by the gamma spectral analyses of samples of shoreline sediment. The results from the analysis of shoreline sediment are provided in Table H-16.

ASSESSMENT AND EVALUATION

Potential doses to the public are estimated from measured effluents using computer models. These models were developed by TVA and are based on methodology provided by the NRC in Regulatory Guide 1.109 for determining the potential dose to individuals and populations living in the vicinity of a nuclear power plant. The results of the effluent dose calculations are reported in the Annual Radioactive Effluent Release Report. The doses calculated are a representation of the dose to a "maximum exposed individual." Some of the factors used in these calculations (such as ingestion rates) are maximum expected values which will tend to overestimate the dose to this "hypothetical" person. The calculated maximum dose due to plant effluents are small fractions of the applicable regulatory limits. In reality, the expected dose to actual individuals is significantly lower.

Based on the very low concentrations of radionuclides actually present in the plant effluents, radioactivity levels measured in the environment as a result of plant operations are expected to be negligible. The results for the radiological environmental monitoring conducted for the BFN 2004 operations confirm this expectation.

Results

As stated earlier in the report, the estimated increase in radiation dose equivalent to the general public resulting from the operation of BFN is negligible when compared to the dose from natural background radiation. The results from each environmental sample are compared with the concentrations from the corresponding control stations and appropriate preoperational and background data to determine influences from the plant. During this report period, Cs-137 was identified in soil and fish samples. The distribution of Cs-137 in fish is consistent with fallout levels identified in samples during the preoperational phase of the monitoring program. The Cs-137 detected in soil was consistent with levels generally found in the environment as the result of past nuclear weapons testing.

Conclusions

It is concluded from the above analysis of the environmental sampling results and from the trend plots presented in Appendix H that the exposure to members of the general public which may have been attributable to BFN is negligible. The radioactivity reported herein is primarily the results of fallout or natural background radiation. Any activity which may be present as a result of plant operations does not represent a significant contribution to the exposure of Members of the Public.

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2. National Council on Radiation Protection and Measurements, Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," September 1987.

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Table 1

COMPARISON OF
PROGRAM LOWER LIMITS OF DETECTION WITH THE REGULATORY LIMITS FOR
MAXIMUM ANNUAL AVERAGE EFFLUENT CONCENTRATIONS
RELEASED TO UNRESTRICTED AREAS
AND REPORTING LEVELS

	Concentrations in Water, pCi/Liter			Concentrations in Air, pCi/Cubic Meter		
	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]	Effluent Concentration[1]	Reporting Level[2]	Lower limit of Detection[3]
H-3	1,000,000	20,000	300	100,000		
Cr-51	500,000		45	30,000		0.02
Mn-54	30,000	1,000	5	1,000		0.005
Co-58	20,000	1,000	5	1,000		0.005
Co-60	3,000	300	5	50		0.005
Zn-65	5,000	300	10	400		0.005
Sr-89	8,000		5	1,000		0.0011
Sr-90	500		2	6		0.0004
Nb-95	30,000	400	5	2,000		0.005
Zr-95	20,000	400	10	400		0.005
Ru-103	30,000		5	900		0.005
Ru-106	3,000		40	20		0.02
I-131	1,000	2	0.4	200	0.9	0.03
Cs-134	900	30	5	200	10	0.005
Cs-137	1,000	50	5	200	20	0.005
Ce-144	3,000		30	40		0.01
Ba-140	8,000	200	25	2,000		0.015
La-140	9,000	200	10	2,000		0.01

Note: 1 pCi = 3.7×10^{-2} Bq.

Note: For those reporting levels that are blank, no value is given in the reference.

1 Source: Table 2 of Appendix B to 10 CFR 20.

2 Source: BFN Offsite Dose Calculation Manual, Table 2.3-3.

3 Source: Table E-1 of this report.

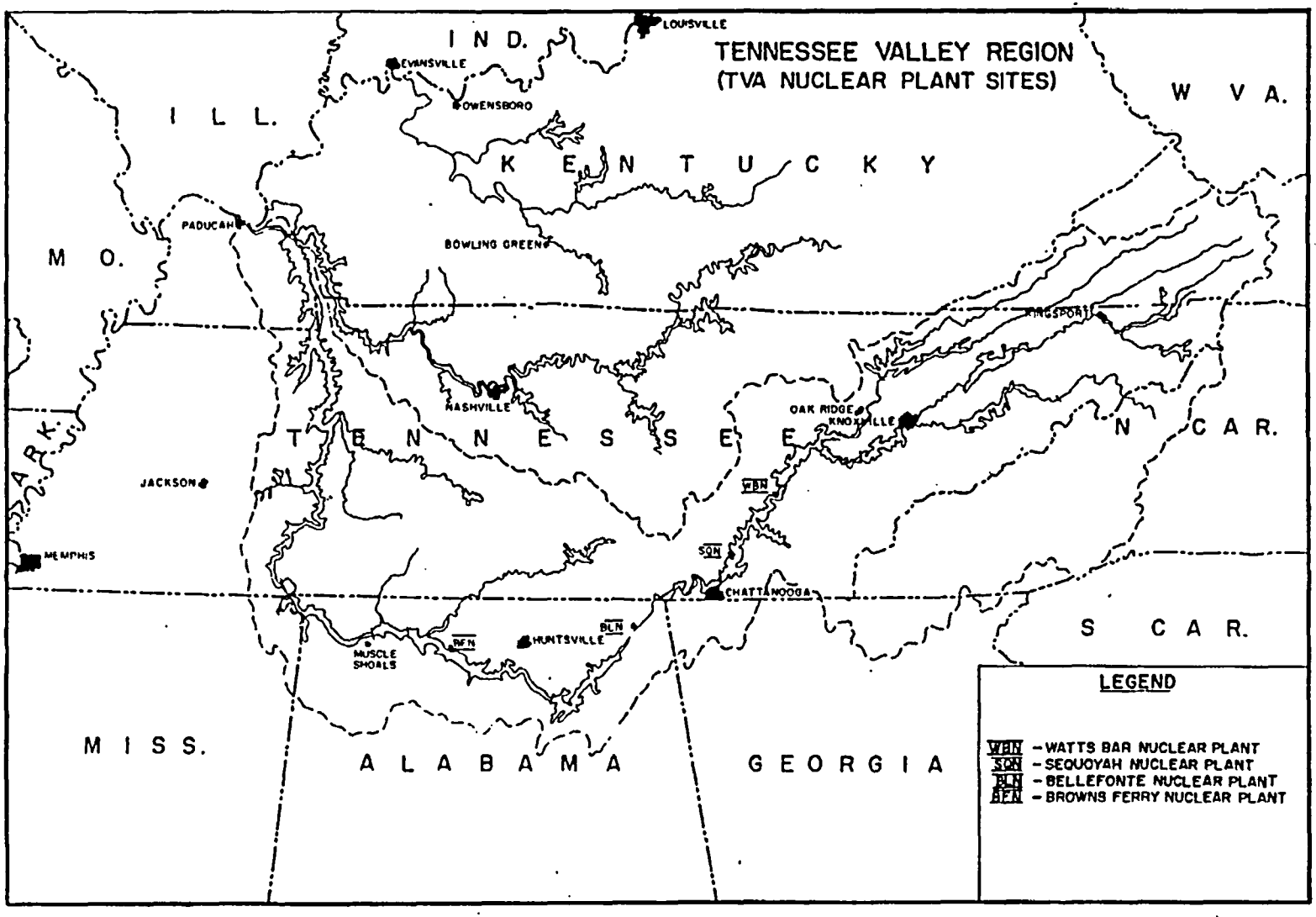
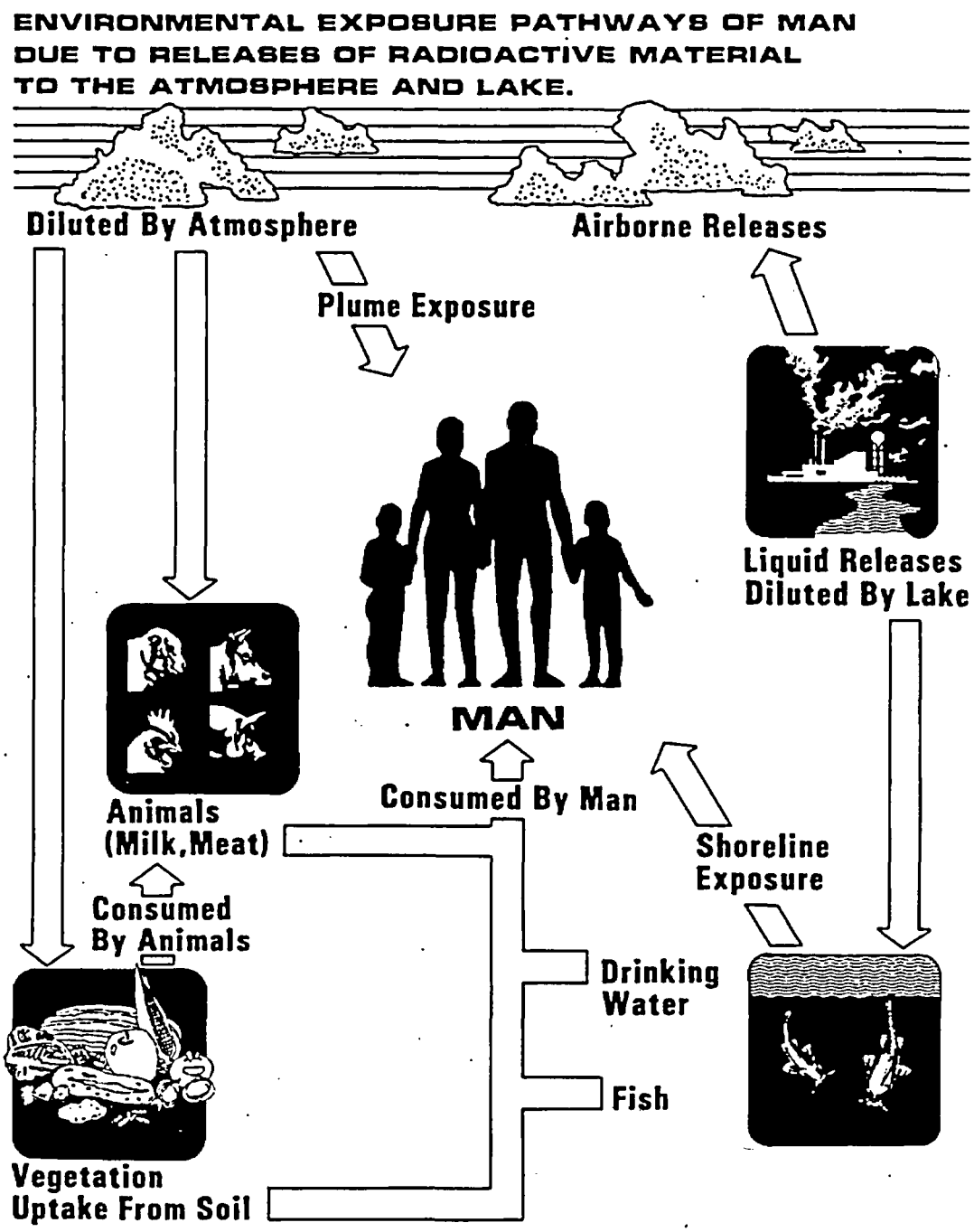

TENNESSEE VALLEY REGION
(TVA NUCLEAR PLANT SITES)
LOUISVILLE
IND.
EVANSVILLE
OWENSBORO
ILL.
W VA.
KENTUCKY
PADUCAH
BOWLING GREEN
MO.
KINGSPORT
NASHVILLE
OAK RIDGE
KNOXVILLE
ARK.
TENNESSEE
N CAR.
JACKSON
WBN
SQN
MEMPHIS
CHATTANOOGA
S CAR.
BLN
BFN
HUNTSVILLE
MUSCLE SHOALS
MISS.
ALABAMA
GEORGIA
LEGEND
WBN - WATTS BAR NUCLEAR PLANT
SQN - SEQUOYAH NUCLEAR PLANT
BLN - BELLEFONTE NUCLEAR PLANT
BFN - BROWNS FERRY NUCLEAR PLANT

Figure 1

Figure 2


ENVIRONMENTAL EXPOSURE PATHWAYS OF MAN
DUE TO RELEASES OF RADIOACTIVE MATERIAL
TO THE ATMOSPHERE AND LAKE.
Diluted By Atmosphere
Airborne Releases
Plume Exposure
Liquid Releases
Diluted By Lake
MAN
Consumed By Man
Animals
(Milk,Meat)
Shoreline
Exposure
Consumed
By Animals
Drinking
Water
Fish
Vegetation
Uptake From Soil

APPENDIX A

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM AND SAMPLING LOCATIONS

Table A-1
BROWNS FERRY NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Particulates	Six samples from locations (in different sectors) at or near the site boundary (LM-1, LM-2, LM-3, LM-4, LM-6, and LM-7). Two samples from control locations greater than 10 miles from the plant (RM-1 and RM-6). Three samples from locations in communities approximately 10 miles from the plant (PM-1, PM-2, and PM-3).	Continuous sampler operation with sample collection as required by dust loading but at least once per 7 days.	Analyze for gross beta radioactivity greater than or equal to 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is greater than 10 times the average of control samples. Perform gamma isotopic analysis on composite (by location) sample at least once per 31 days.
b. Radioiodine	Same locations as air particulates.	Continuous sampler operation with charcoal canister collection at least once per 7 days.	I-131 by gamma scan on each sample.
c. Rainwater	Same locations as air particulates.	Composite sample at least once per 31 days.	Analyzed for gamma nuclides only if radioactivity in other media indicates the presence of increased levels of fallout

Table A-1
BROWNS FERRY NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
d. Soil	Samples from same locations as air particulates.	Once every year.	Gamma scan, Sr-89, Sr-90 once per year.
e. Direct	Two or more dosimeters placed at locations (in different sectors) at or near the site boundary in each of the 16 sectors.	At least once per 92 days.	Gamma dose once per 92 days.
	Two or more dosimeters placed at stations located approximately 5 miles from the plant in each of the 16 sectors.	At least once per 92 days.	Gamma dose once per 92 days.
	Two or more dosimeters in at least 9 additional locations of special interest.		
2. WATERBORNE			
a. Surface Water	One sample upstream (TRM 306.0). One sample immediately downstream of discharge (TRM 293.5).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[c].	Gross beta and gamma scan on 4-week composite. Composite for tritium at least once per 92 days.
b. Drinking water	One sample at the first potable surface water supply downstream from the plant (TRM 286.5).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[c].	Gross beta and gamma scan on 4-week composite. Composite for tritium analysis at least once per 92 days.

Table A-1
BROWNS FERRY NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Drinking Water (Continued)	Four additional samples of potable surface water downstream from the plant (TRM 282.6, TRM 274.9, TRM 259.8 and TRM 259.6).	Grab sample taken from water supply at a facility using water from the public supply being monitored. Sample collected at least once per 31 days.	Gross beta and gamma scan on 4-week composite. Composite for tritium analysis at least once per 92 days.
	One sample at a control location[d] (TRM 306).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days[c].	Same as downstream location.
d. Ground water	One sample adjacent to the plant (Well No. 6).	Collected by automatic sequential-type sampler with composite sample taken at least once per 31 days.	Gamma scan on each composite. Composite for tritium analysis at least once per 92 days.
	One sample at a control location up gradient from the plant.	Grab sample taken at least once per 31 days.	Gamma scan on each sample. Composite for tritium analysis at least once per 92 days.
e. Shoreline Sediment	One sample upstream from a recreational area (TRM 305).	At least once per 184 days.	Gamma scan of each sample.

Table A-1
BROWNS FERRY NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
e. Shoreline Sediment (Continued)	One sample from each of at least two downstream locations with recreational use (TRM 293 and 279.5).	At least once per 184 days.	Gamma scan of each sample.
4. INGESTION			
a. Fish	Two samples representing commercial and game species in Guntersville Reservoir above the plant. Two samples representing commercial and game species in Wheeler Reservoir near the plant.	At least once per 184 days.	Gamma scan at least once per 184 days on edible portions.

Table A-1
BROWNS FERRY NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM[a]

Exposure Pathway and/or Sample	Number of Samples and Locations[b]	Sampling and Collection Frequency	Type and Frequency of Analysis
b. Fruits and Vegetables	Samples of food crops such as greens, corn, green beans, tomatoes, and potatoes grown at private gardens and/or farms in the immediate vicinity of the plant. One sample of each of the same foods grown at greater than 10 miles distance from the plant.	At least once per year at time of harvest.	Gamma scan on edible portion.

a. The sampling program outlined in this table is the program conducted during 2004.
b. Sample locations, sector and distance from plant, are described in Table A-2 and A-3 and shown in Figures A-1, A-2, and A-3.
c. Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
d. The sample location at the Decatur City Water Plant serves as a control sample for both surface water and drinking water.

Table A-2
BROWNS FERRY NUCLEAR PLANT
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM
SAMPLING LOCATIONS

Map Location Number[a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected[b]
1	PM-1	NW	13.8	I	AP,CF,R,S
2	PM-2	NE	10.9	I	AP,CF,R,S
3	PM-3	SSE	7.5	I	AP,CF,R,S
4	LM-7	W	2.1	I	AP,CF,R,S
5	RM-1	W	31.0	C	AP,CF,R,S
6	RM-6	E	23.4	C	AP,CF,R,S
7	LM-1	NNW	1.0	I	AP,CF,R,S
8	LM-2	NNE	0.9	I	AP,CF,R,S
9	LM-3	ENE	0.9	I	AP,CF,R,S
10	LM-4	NNW	1.7	I	AP,CF,R,S
11	LM-6	SSW	3.0	I	AP,CF,R,S
12	Farm B	NNW	6.8	I	W
22	Well No.6	NW	0.02	I	W
23	TRM[c] 282.6	-	11.4[d]	I	PW
24	TRM 306.0	-	12.0[d]	C	PW, SW
25	TRM 259.6	-	34.4[d]	I	PW
26	TRM 274.9	-	19.1[d]	I	PW
28	TRM 293.5	-	0.5[d]	I	SW
70	TRM 259.8	-	34.2[d]	I	PW
71	TRM 286.5	-	7.5[d]	I	PW
72	TRM 305	-	11.0[d]	C	SS
73	TRM 293	-	1.0[d]	I	SS
74	TRM 279.5	-	14.5[d]	I	SS
	Wheeler Reservoir (TRM 275-349)		-	I	F
	Guntersville Reservoir (TRM 349-424)		-	C	F

a. See Figures A-1, A-2, and A-3
b. Sample codes:
AP = Air particulate filter
CF = Charcoal filter (Iodine)
PW = Public drinking water
F = Fish
S = Soil
SS = Shoreline sediment
R = Rainwater
W = Well water
SW = Surface Water
c. TRM = Tennessee River Mile.
d. Miles from plant discharge at (TRM 294).

Table A-3
BROWNS FERRY NUCLEAR PLANT
THERMOLUMINESCENT DOSIMETER (TLD) LOCATIONS

Map Location Number[a]	Station	Sector	Approximate Distance (miles)	Onsite (On)[b] or Offsite (Off)
1	NW-3	NW	13.8	Off
2	NE-3	NE	10.9	Off
3	SSE-2	SSE	7.5	Off
5	W-3	W	31.0	Off
6	E-3	E	23.1	Off
7	N-1	NNW	1.0	On
8	NNE-1	NNE	0.9	On
9	ENE-1	ENE	0.9	On
10	NNW-2	NNW	1.7	On
38	N-2	N	5.0	Off
39	NNE-2	NNE	0.7	On
40	NNE-3	NNE	5.2	Off
41	NE-1	NE	0.8	On
42	NE-2	NE	5.0	Off
43	ENE-2	ENE	6.2	Off
44	E-1	E	0.8	On
45	E-2	E	5.2	Off
46	ESE-1	ESE	0.9	On
47	ESE-2	ESE	3.0	Off
48	SE-1	SE	0.5	On
49	SE-2	SE	5.4	Off
50	SSE-1	SSE	5.1	Off
51	S-1	S	3.1	Off
52	S-2	S	4.8	Off
53	SSW-1	SSW	3.0	Off
54	SSW-2	SSW	4.4	Off
55	SW-1	SW	1.9	On
56	SW-2	SW	4.7	Off
57	SW-3	SW	6.0	Off
58	WSW-1	WSW	2.7	Off
59	WSW-2	WSW	5.1	Off
60	WSW-3	WSW	10.5	Off
61	W-1	W	1.9	On
62	W-2	W	4.7	Off
63	W-4	W	31.7	Off
64	WNW-1	WNW	3.3	Off
65	WNW-2	WNW	4.4	Off
66	NW-1	NW	2.2	Off
67	NW-2	NW	5.3	Off
68	NNW-1	NNW	1.0	On
69	NNW-3	NNW	5.2	Off
75	N-1A	N	1.0	On

a. See Figures A-1, A-2, and A-3.
b. TLDs designated "onsite" are those located 2 miles or less from the plant.
TLDS designated "offsite" are those located more than 2 miles from the plant.

Figure A-1

Radiological Environmental Monitoring Locations

Within 1 Mile of Plant

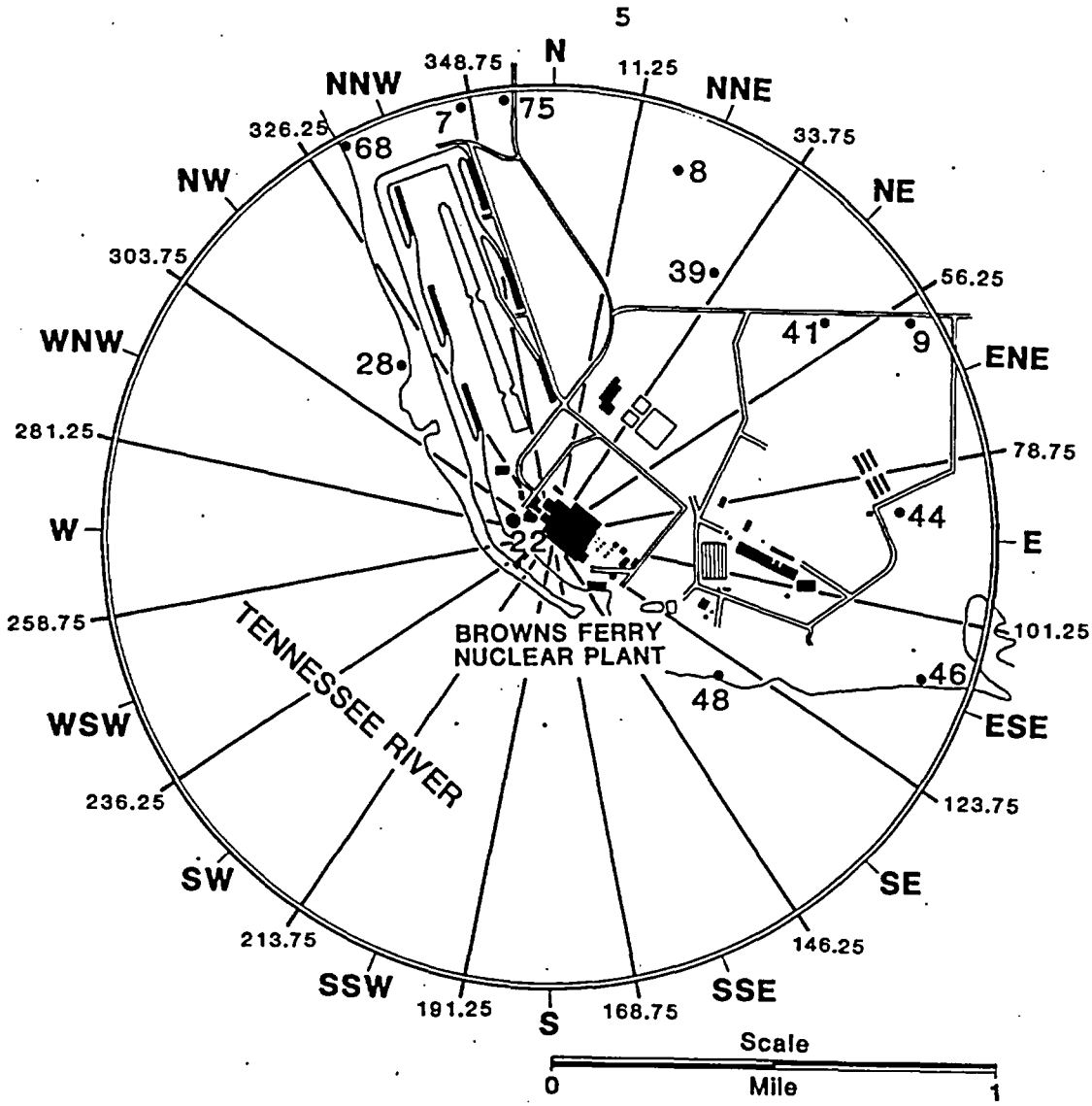


Figure A-2

Radiological Environmental Monitoring Locations

From 1 to 5 Miles from the Plant

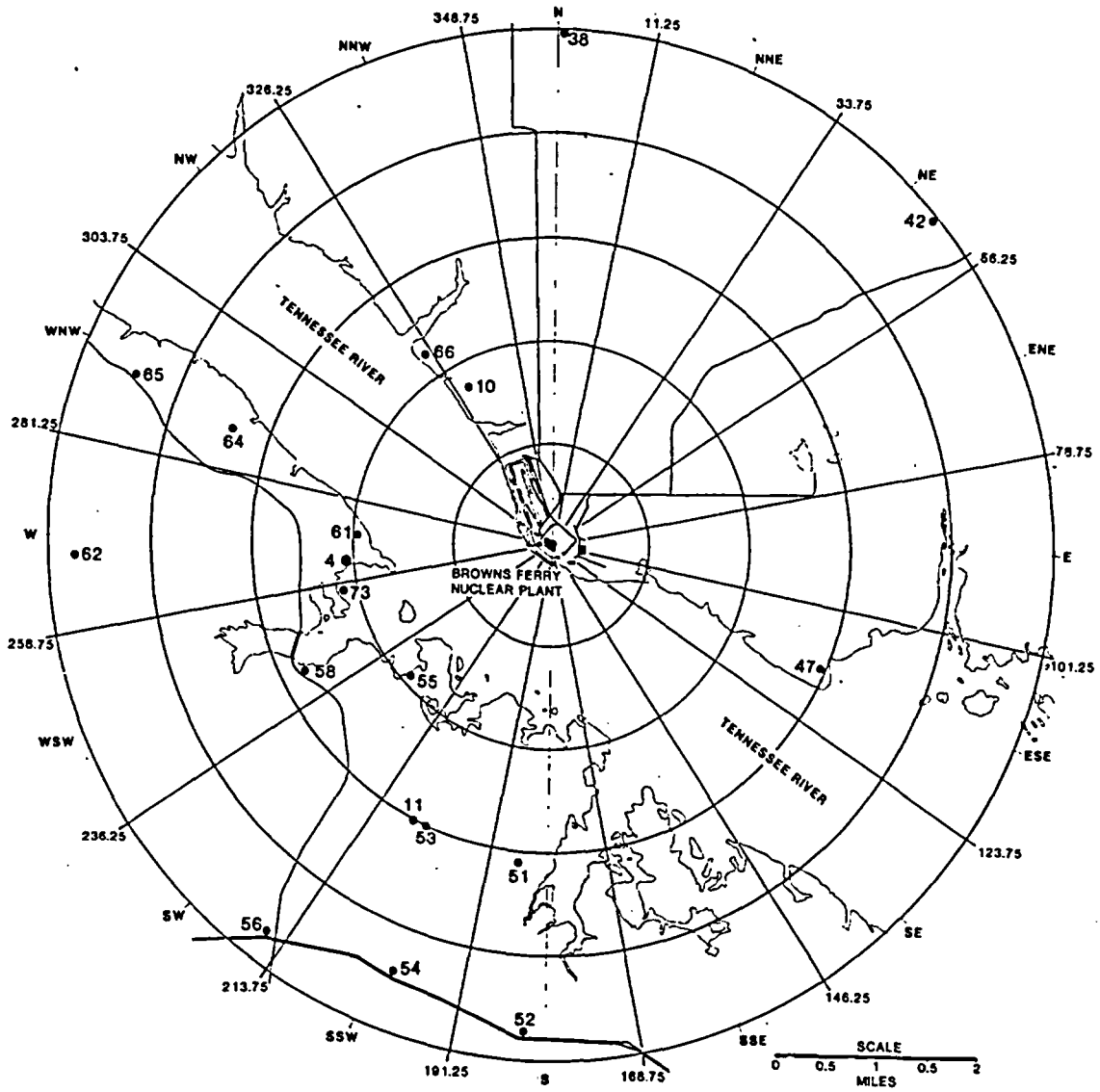
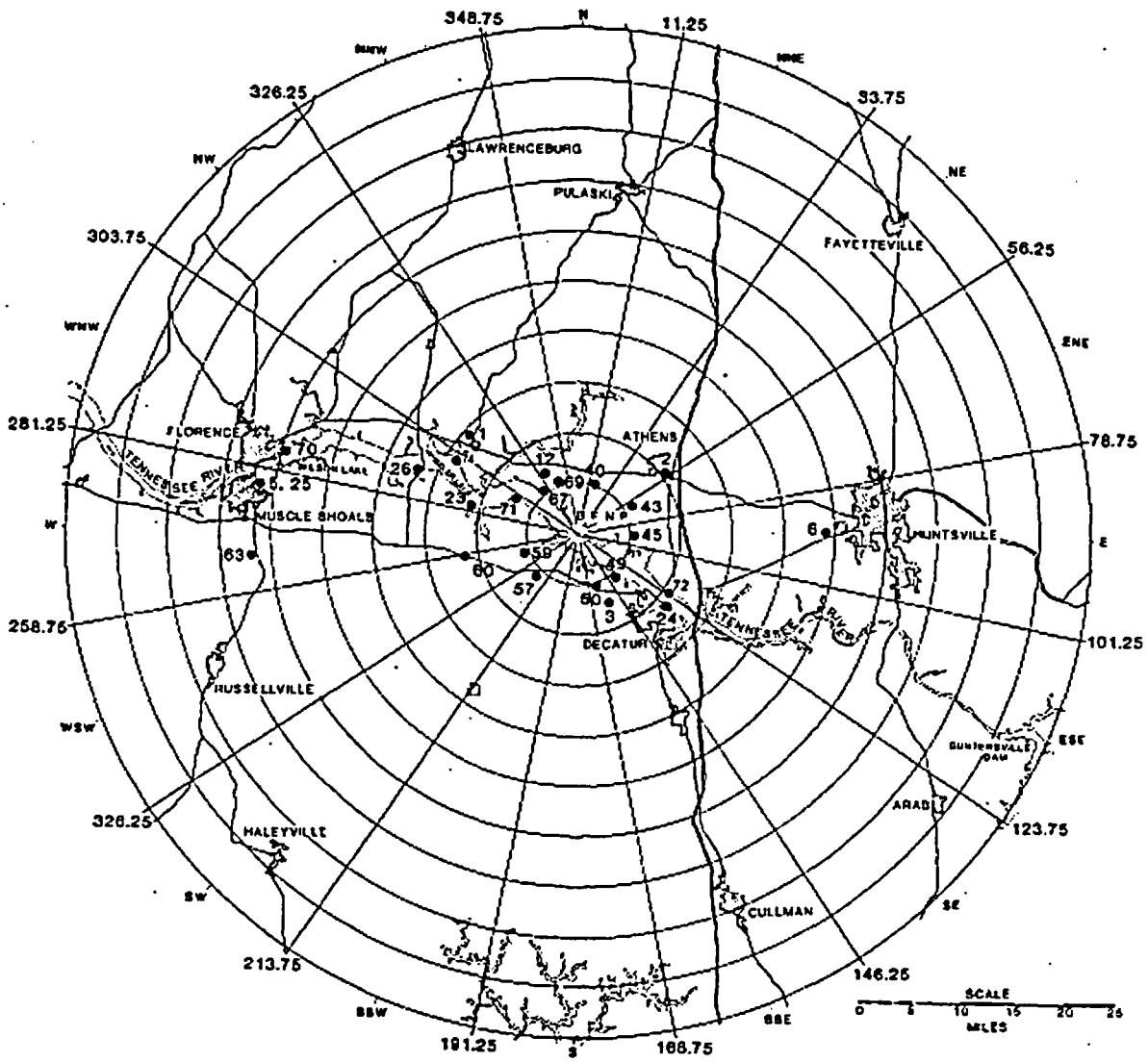


Figure A-3

Radiological Environmental Monitoring Locations

Greater than 5 miles from the Plant



APPENDIX B

2004 PROGRAM MODIFICATIONS

APPENDIX B

Radiological Environmental Monitoring Program Modifications

There were no modifications to the BFN REMP during 2004.

APPENDIX C

PROGRAM DEVIATIONS

APPENDIX C

Program Deviations

During 2004, problems with sampling equipment resulted in sample unavailability or inadequate sample volumes for two sets of air particulate filter and charcoal cartridge samples. Table C-1 provides additional details on these program deviations.

Table C-1

Radiological Environmental Monitoring Program Deviations

Date	Station	Location	Remarks
04/26/04	LM-6	3.0 miles SSW	The total sample volume for air filter and charcoal cartridge samples was not adequate due to a problem with the sampling pump. The problem was a broken drive belt. The belt was replaced and the system returned to normal operation for the next sampling cycle. The missed samples were documented with PER 60169.
10/25/04	RM-1	31.0 miles W	The total sample volume for air filter and charcoal cartridge samples was not adequate due to a failure of the sampling pump. The problem was found to be a loss of power due to a trip of the circuit breaker caused by severe thunderstorms in the area. The power to the sampler was restored and the system returned to normal operation for the next sampling cycle. The missed samples were documented with PER 70931.

APPENDIX D

ANALYTICAL PROCEDURES

Appendix D

Analytical Procedures

Analyses of environmental samples are performed by the radioanalytical laboratory located at the WARL facility in Muscle Shoals. All analysis procedures are based on accepted methods. A summary of the analysis techniques and methodology follows.

The gross beta measurements are made with an automatic low background counting system. Normal counting times are 50 minutes. Water samples are prepared by evaporating 500 ml of samples to near dryness, transferring to a stainless steel planchet and completing the evaporation process. Air particulate filters are counted directly in a shallow planchet.

After a radiochemical separation, samples analyzed for Sr-89, 90 are counted on a low background beta counting system. The sample is counted a second time after a 7-day ingrowth period. From the two counts the Sr-89 and Sr-90 concentrations can be determined.

Water samples are analyzed for tritium content by first distilling a portion of the sample and then counting by liquid scintillation. A commercially available scintillation cocktail is used.

Gamma analyses are performed in various counting geometries depending on the sample type and volume. Gamma counts are obtained with germanium detectors interfaced with a computer based multichannel analyzer system. Spectral data reduction is performed by the computer program HYPERMET.

The charcoal cartridges used to sample gaseous radioiodine were analyzed by gamma spectroscopy using a high resolution spectroscopy system with germanium detectors.

The necessary efficiency values, weight-efficiency curves, and geometry tables are established and maintained on each detector and counting system. A series of daily and periodic quality control checks are performed to monitor counting instrumentation. System logbooks and control charts are used to document the results of the quality control checks.

APPENDIX E

NOMINAL LOWER LIMITS OF DETECTION (LLD)

Appendix E

Nominal Lower Limits of Detection (LLD)

A number of factors influence the LLD for a specific analytical method, including sample size, count time, count efficiency, chemical processes, radioactive decay factors, and interfering isotopes encountered in the sample. The most probable values for these factors have been evaluated for the various analyses performed in the environmental monitoring program. The nominal LLDs are calculated from these values in accordance with the methodology prescribed in the ODCM. These nominal LLD values are presented in Table E-1. The maximum values for the lower limits of detection specified in the ODCM are shown in Table E-2.

The nominal LLDs are also presented in the data tables. For analyses for which nominal LLDs have not been established, a LLD of zero is assumed in determining if a measured activity is greater than the nominal LLD.

TABLE E-1

Nominal LLD Values
A. Radiochemical Procedures

	Air Filters (pCi/m^3)	Water (pCi/L)	Milk (pCi/L)	Wet Vegetation (pCi/Kg wet)	Sediment and Soil (pCi/g dry)
Gross Beta	0.002	1.9			
Tritium		300			
Iodine-131		0.4	0.4	6.0	
Strontium-89		5.0	3.5	31.0	1.6
Strontium-90		2.0	2.0	12.0	0.4

Table E-1
Nominal LLD Values
B. Gamma Analyses (GeLi)

	Air Particulates pCi/m3	Charcoal Filter pCi/m3	Water And Milk pCi/L	Vegetation and Grain pCi/g, dry	Wet Vegetation pCi/kg, wet	Soil and Sediment pCi/g, dry	Fish pCi/g, dry	Clam Flesh pCi/g, dry	Foods Tomatoes Potatoes, etc. pCi/kg, wet
Ce-141	.005	.02	10	.07	35	.10	.07	.35	20
Ce-144	.01	.07	30	.15	115	.20	.15	.85	60
Cr-51	.02	0.15	45	.30	200	.35	.30	2.4	95
I-131	.005	0.03	10	.20	60	.25	.20	1.7	20
Ru-103	.005	0.02	5	.03	25	.03	.03	.25	25
Ru-106	.02	0.12	40	.15	190	.20	.15	1.25	90
Cs-134	.005	0.02	5	.03	30	.03	.03	.14	10
Cs-137	.005	0.02	5	.03	25	.03	.03	.15	10
Zr-95	.005	0.03	10	.05	45	.05	.05	.45	45
Nb-95	.005	0.02	5	.25	30	.04	.25	.25	10
Co-58	.005	0.02	5	.03	20	.03	.03	.25	10
Mn-54	.005	0.02	5	.03	20	.03	.03	.20	10
Zn-65	.005	0.03	10	.05	45	.05	.05	.40	45
Co-60	.005	0.02	5	.03	20	.03	.03	.20	10
K-40	.04	0.30	100	.40	400	.75	.40	3.50	250
Ba-140	.015	0.07	25	.30	130	.30	.30	2.4	50
La-140	.01	0.04	10	.20	50	.20	.20	1.4	25
Fe-59	.005	0.04	10	.08	40	.05	.08	.45	25
Be-7	.02	0.15	45	.25	200	.25	.25	1.9	90
Pb-212	.005	0.03	15	.04	40	.10	.04	.30	40
Pb-214	.005	0.07	20	.50	80	.15	.50	.10	80
Bi-214	.005	0.05	20	.10	55	.15	.10	.50	40
Bi-212	.02	0.20	50	.25	250	.45	.25	2.0	130
Tl-208	.002	0.02	10	.03	30	.06	.03	.25	30
Ra-224	--	--	--	--	--	.75	--	--	--
Ra-226	--	--	--	--	--	.15	--	--	--
Ac-228	.01	0.07	20	.10	70	.25	.10	.75	50

Table E-2

Maximum Values for the Lower Limits of Detection (LLD)
Specified by the BFN Offsite Dose Calculation Manual

Analysis	Water pCi/L	Airborne Particulate or Gases pCi/m^3	Fish pCi/kg, wet	Milk pCi/L	Food Products pCi/kg, wet	Sediment pCi/kg, dry
gross beta	4	1×10^{-2}	N.A.	N.A.	N.A.	N.A.
H-3	2000[a]	N.A.	N.A.	N.A.	N.A.	N.A.
Mn-54	15	N.A.	130	N.A.	N.A.	N.A.
Fe-59	30	N.A.	260	N.A.	N.A.	N.A.
Co-58, 60	15	N.A.	130	N.A.	N.A.	N.A.
Zn-65	30	N.A.	260	N.A.	N.A.	N.A.
Zr-95	30	N.A.	N.A.	N.A.	N.A.	N.A.
Nb-95	15	N.A.	N.A.	N.A.	N.A.	N.A.
I-131	1[b]	7×10^{-2}	N.A.	1	60	N.A.
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-140	60	N.A.	N.A.	60	N.A.	N.A.
La-140	15	N.A.	N.A.	15	N.A.	N.A.

a. If no drinking water pathway exists, a value of 3000 pCi/liter may be used.

b. LLD for analysis of drinking water and surface water samples shall be performed by gamma spectroscopy at approximately 15 pCi/liter. If levels greater than 15 pCi/liter are identified in surface water samples downstream from the plant, or in the event of an unanticipated release of I-131, drinking water samples will be analyzed at an LLD of 1.0 pCi/liter for I-131.

APPENDIX F

QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

Appendix F

Quality Assurance/Quality Control Program

A thorough quality assurance program is employed by the laboratory to ensure that the environmental monitoring data are reliable. This program includes the use of written, approved procedures in performing the work, provisions for staff training and certification, internal self assessments of program performance, audits by various external organizations, and a laboratory quality control program.

The quality control program employed by the radioanalytical laboratory is designed to ensure that the sampling and analysis process is working as intended. The program includes equipment checks and the analysis of quality control samples along with routine samples. Instrument quality control checks include background count rate and counts reproducibility. In addition to these two general checks, other quality control checks are performed on the variety of detectors used in the laboratory. The exact nature of these checks depends on the type of device and the method it uses to detect radiation or store the information obtained.

Quality control samples of a variety of types are used by the laboratory to verify the performance of different portions of the analytical process. These quality control samples include blanks, replicate samples, blind samples, or cross-checks.

Blanks are samples which contain no measurable radioactivity or no activity of the type being measured. Such samples are analyzed to determine whether there is any contamination of equipment or commercial laboratory chemicals, cross-contamination in the chemical process, or interference from isotopes other than the one being measured.

Duplicate samples are generated at random by the sample computer program which schedules the collection of the routine samples. For example, if the routine program calls for four milk samples every week, on a random basis each farm might provide an additional sample several

times a year. These duplicate samples are analyzed along with other routine samples. They provide information about the variability of radioactive content in the various sample media.

If enough sample is available for a particular analysis, the laboratory staff can split it into two portions. Such a sample provides information about the variability of the analytical process since two identical portions of material are analyzed side by side.

Analytical knowns are another category of quality control sample. A known amount of radioactivity is added to a sample medium. The lab staff knows the radioactive content of the sample. Whenever possible, the analytical knowns contain the same amount of radioactivity each time they are run. In this way, analytical knowns provide immediate data on the quality of the measurement process. A portion of these samples are also blanks.

Blind spikes are samples containing radioactivity which are introduced into the analysis process disguised as ordinary environmental samples. The lab staff does not know the sample contains radioactivity. Since the bulk of the ordinary workload of the environmental laboratory contains no measurable activity or only naturally occurring radioisotopes, blind spikes can be used to test the detection capability of the laboratory or can be used to test the data review process. If an analysis routinely generates numerous zeroes for a particular isotope, the presence of the isotope is brought to the attention of the laboratory supervisor in the daily review process. Blind spikes test this process since the blind spikes contain radioactivity at levels high enough to be detected. Furthermore, the activity can be put into such samples at the extreme limit of detection (near the LLD) to determine whether or not the laboratory can find any unusual radioactivity whatsoever.

At present, 5 percent of the laboratory workload is in the category of internal cross-checks. These samples have a known amount of radioactivity added and are presented to the lab staff labeled as cross-check samples. This means that the quality control staff knows the radioactive

content or "right answer" but the lab personnel performing the analysis do not. Such samples test the best performance of the laboratory by determining if the lab can find the "right answer". These samples provide information about the accuracy of the measurement process. Further information is available about the variability of the process if multiple analyses are requested on the same sample. Like blind spikes or analytical knowns, these samples can also be spiked with low levels of activity to test detection limits. During 2004, all analysis results for internal cross-check samples were within agreement limits when compared to the known value.

To provide for an independent verification of the laboratory's ability to make accurate measurements, the laboratory participated in an environmental level cross-check program available through Analytics, Inc., during 2004. The results of TVA's participation in this cross-check program are presented in Table F-1.

TVA splits certain environmental samples with laboratories operated by the States of Alabama and Tennessee and the EPA National Air and Radiation Environmental Laboratory in Montgomery, Alabama. When radioactivity has been present in the environment in measurable quantities, such as following atmospheric nuclear weapons testing, following the Chernobyl incident, or as naturally occurring radionuclides, the split samples have provided TVA with another level of information about laboratory performance. These samples demonstrate performance on actual environmental sample matrices rather than on the constructed matrices used in cross-check programs.

The quality control data are routinely collected, examined and reported to laboratory supervisory personnel. They are checked for trends, problem areas, or other indications that a portion of the analytical process needs correction or improvement. The end result is a measurement process that provides reliable and verifiable data and is sensitive enough to measure the presence of radioactivity far below the levels which could be harmful to humans.

Table F-1

Results For 2004 External Cross Checks

Test Period	Sample Type / Analysis	Results		3 Sigma Range		
		Known	TVA			
First Quarter	Water (pCi/L)					
	Gross Beta	276	263	235	-	317
First Quarter	Charcoal Filter (pCi/Filter)					
	^{131}I	97	72	68	-	126
First Quarter	Water (pCi/L)					
	^{131}I	90	89	75	-	105
	^{141}Ce	85	86	70	-	100
	^{51}Cr	326	340	228	-	424
	^{134}Cs	90	79	75	-	105
	^{137}Cs	185	177	157	-	213
	^{58}Co	112	114	95	-	129
	^{54}Mn	114	116	97	-	131
	^{59}Fe	57	75	42	-	72
	^{65}Zn	143	153	100	-	186
	^{60}Co	153	154	130	-	176
First Quarter	Water (pCi/L)					
	^{89}Sr	123	113	105	-	141
	^{90}Sr	15	16	0	-	30
Third Quarter	Water (pCi/L)					
	^{3}H	12000	11900	8400	-	15600
Third Quarter	Sand (pCi/g)					
	^{141}Ce	0.460	0.406	0.391	-	0.529
	^{51}Cr	0.411	0.410	0.288	-	0.534
	^{134}Cs	0.178	0.176	0.151	-	0.205
	^{137}Cs	0.396	0.365	0.337	-	0.455
	^{58}Co	0.174	0.163	0.148	-	0.200
	^{54}Mn	0.334	0.336	0.284	-	0.384
	^{59}Fe	0.168	0.165	0.143	-	0.193
	^{65}Zn	0.328	0.326	0.230	-	0.426
	^{60}Co	0.231	0.228	0.196	-	0.266
Third Quarter	Air Filter (pCi/Filter)					
	Gross Beta	196	189	167	-	225
Third Quarter	Air Filter (pCi/Filter)					
	^{141}Ce	145	145	123	-	167
	^{51}Cr	130	122	91	-	169
	^{134}Cs	56	47	41	-	71
	^{137}Cs	125	124	106	-	144
	^{58}Co	55	55	40	-	70
	^{54}Mn	106	113	90	-	122
	^{59}Fe	53	52	38	-	68
	^{65}Zn	104	113	73	-	135
	^{60}Co	73	73	58	-	88

APPENDIX G

LAND USE SURVEY

Appendix G

Land Use Survey

A land use survey was conducted to identify the nearest milk animal, the nearest residence, and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of 16 meteorological sectors within a distance of 5 miles from the plant. The land use survey also identifies all gardens of greater than 500 square feet producing fresh leafy vegetables within a distance of 3 miles from the plant.

The land use survey was conducted between April 1 and October 1 using appropriate techniques such as door-to-door survey, mail survey, telephone survey, aerial survey, or information from local agricultural authorities or other reliable sources.

In order to identify the locations around BFN which have the greatest relative potential for impact by the plant, radiation doses were projected for individuals living near BFN. These projections used the data obtained in the survey and historical meteorological data. The calculations also assumed that releases were equivalent to the design basis source terms. The dose projections are relative in nature and do not reflect actual exposures to individuals living near BFN.

Dose projections from air submersion were calculated for the nearest resident in each sector and dose projections from eating foods produced near the plant were calculated for the areas with gardens.

There were no changes in the distance for the location of the nearest resident in 2004 as compared to 2003. The location of the nearest garden as identified in the 2004 survey changed in one sector compared to the locations identified in 2003.

There were no locations identified within the five mile radius with milk production for human consumption

Tables G-1, and G-2 show the comparative calculated doses for 2003 and 2004.

Table G-1

BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Air Submersion Dose to the Nearest Resident
Within 8 km (5 Miles) of Plant
mrem/year

	2003 Survey		2004 Survey	
Sector	Approximate Distance Meters	Annual Dose	Approximate Distance Meters	Annual Dose
N	2000	0.45	2000	0.45
NNE	2590	0.14	2590	0.14
NE	4096	0.12	4096	0.12
ENE	2458	0.17	2458	0.17
E	1290	0.47	1290	0.47
ESE	1860	0.22	1860	0.22
SE	a		a	
SSE	a		a	
S	4482	0.15	4482	0.15
SSW	4169	0.18	4169	0.18
SW	4458	0.10	4458	0.10
WSW	3976	0.08	3976	0.08
W	2530	0.19	2530	0.19
WNW	5470	0.10	5470	0.10
NW	3373	0.30	3373	0.30
NNW	1639	0.76	1639	0.76

Note a - There is no residence within the 8 km radius for this section

Table G-2

BROWNS FERRY NUCLEAR PLANT

Relative Projected Annual Dose to Child's Bone from
Ingestion of Home-Grown Foods
mrem/year

	2003 Survey		2004 Survey		
Sector	Approximate Distance Meters	Annual Dose	Approximate Distance Meters	Annual Dose	Number of Gardens Within 3 miles (2004)
N	4572	2.64	4572	2.64	1
NNE	5940	0.89	5940	0.89	1
NE	4313	1.27	4313	1.27	1
ENE	4319	1.33	4319	1.33	1
E	4340	1.75	4340	1.75	1
ESE	2592	3.93	2125	5.03	3
SE	a		a		0
SSE	a		a		0
S	4482	2.28	4482	2.28	1
SSW	4169	2.68	4169	2.68	2
SW	4458	1.15	4458	1.15	1
WSW	4578	0.56	4578	0.56	1
W	2977	1.15	2977	1.15	1
WNW	a		a		0
NW	a		a		0
NNW	1791	9.95	1791	9.95	2

note a – Garden not found within 8 km radius.

APPENDIX H

DATA TABLES AND FIGURES

Table H - 1

DIRECT RADIATION LEVELS

Average External Gamma Radiation Levels at Various Distances from BROWNS FERRY Nuclear Plant for Each Quarter - 2004
mR / Quarter (a)

Distance Miles	Average External Gamma Radiation Levels (b)				per annum mR/yr
	1st qtr	2nd qtr	3rd qtr	4th qtr	
0 - 1	16.5 ± 0.9	18.2 ± 1.1	18.0 ± 1.2	17.0 ± 1.1	70
1 - 2	15.1 ± 0.4	16.5 ± 1.0	16.4 ± 0.9	15.6 ± 1.2	64
2 - 4	14.2 ± 0.9	15.6 ± 1.2	15.1 ± 1.2	14.4 ± 1.3	59
4 - 6	14.3 ± 1.3	15.4 ± 0.9	15.2 ± 1.0	14.4 ± 0.8	59
> 6	14.2 ± 1.0	15.3 ± 1.0	14.5 ± 1.0	14.4 ± 1.0	59
Average, 0 - 2 miles (onsite)	16.1 ± 1.0	17.8 ± 1.3	17.6 ± 1.3	16.7 ± 1.3	68
Average, > 2 miles (offsite)	14.3 ± 1.1	15.4 ± 1.0	15.0 ± 1.1	14.4 ± 1.0	59

(a) Field periods normalized to one standard quarter (2190 hours)
(b) Average of the individual measurements in the set ± 1 standard deviation of the set

TABLE H - 2

DIRECT RADIATION LEVELS

Individual Stations at Browns Ferry Nuclear Plant

Map Location Number	TLD Station Number	Direction, degrees	Approx Distance, miles	Environmental Radiation Levels mR / quarter 1st Qtr Jan - Mar 2004	2nd Qtr Apr - Jun 2004	3rd Qtr Jul Sep 2004	4th Qtr Oct - Dec 2004	Annual Exposure mR/year
7	N-1	348	1.0	17.0	19.6	18.5	18.6	73.7
75	N-1A	365	1.0	17.0	19.9	19.5	18.7	75.0
38	N2	1	5.0	13.8	14.8	13.8	13.4	55.8
8	NNE-1	12	.9	15.4	17.9	17.3	16.6	67.2
39	NNE-2	31	.7	16.4	18.1	18.0	16.8	69.3
40	NNE-3	19	5.2	14.0	15.3	14.8	13.8	57.8
41	NE-1	51	.8	16.0	18.5	19.3	17.9	71.7
42	NE-2	49	5.0	16.3	17.4	17.0	15.9	66.5
2	NE-3	56	10.9	14.9	16.0	14.7	14.9	60.5
9	ENE-1	61	.9	17.6	18.2	18.6	17.0	71.3
43	ENE-2	62	6.2	15.6	16.4	16.3	15.7	63.9
44	E-1	85	.8	18.2	19.3	19.1	17.6	74.2
45	E-2	91	5.2	14.6	15.2	14.9	14.3	59.1
6	E-3	90	24.2	15.1	15.8	15.2	15.7	61.9
46	ESE-1	110	.9	15.0	15.9	15.8	14.9	61.6
47	ESE-2	112	3.0	15.1	16.1	15.1	14.5	60.8
48	SE-1	130	.5	16.3	17.6	17.0	16.4	67.3
49	SE-2	135	5.4	11.2	15.3	14.7	15.0	56.2
50	SSE-1	163	5.1	14.6	15.3	15.3	14.8	59.9
3	SSE-2	165	7.5	14.7	15.9	14.6	15.3	60.5
51	S-1	185	3.1	14.6	15.8	15.9	14.6	60.9

Note: (1) Sum of available quarterly data normalized to 1 year for the annual exposure value.

TABLE H - 2 continued

DIRECT RADIATION LEVELS

Individual Stations at Browns Ferry Nuclear Plant

				Environmental Radiation Levels mR / quarter				
Map Location Number	TLD Station Number	Direction, degrees	Approx Distance, miles	1st Qtr Jan - Mar 2004	2nd Qtr Apr - Jun 2004	3rd Qtr Jul - Sep 2004	4th Qtr Oct - Dec 2004	Annual Exposure mR/year
52	S-2	182	4.8	12.6	13.9	13.7	13.2	53.4
53	SSW-1	203	3.0	12.8	13.7	13.6	12.7	52.8
54	SSW-2	199	4.4	14.0	15.1	15.9	14.2	59.2
55	SW-1	228	1.9	14.6	15.4	15.6	14.5	60.1
56	SW-2	219	4.7	14.4	14.9	15.2	14.5	59.0
57	SW-3	224	6.0	12.9	14.8	14.1	13.4	55.2
58	WSW-1	244	2.7	13.2	14.6	13.7	13.2	54.7
59	WSW-2	251	5.1	15.5	16.1	15.8	15.2	62.5
60	WSW-3	257	10.5	13.7	14.3	14.1	13.6	55.8
61	W-1	275	1.9	15.3	16.3	16.0	15.0	62.6
62	W-2	268	4.7	13.3	14.2	13.6	13.5	54.6
5	W-3	275	31.3	13.2	14.2	13.1	13.7	54.3
63	W-4	265	32.1	15.1	16.7	15.5	14.5	61.8
64	WNW-1	291	3.3	14.5	15.7	15.3	14.3	59.8
65	WNW-2	293	4.4	14.2	15.4	15.3	13.9	58.8
66	NW-1	326	2.2	15.1	17.4	16.9	16.9	66.3
67	NW-2	321	5.3	15.9	16.6	16.7	15.3	64.4
1	NW-3	310	13.8	13.1	13.8	13.2	13.1	53.1
68	NNW-1	331	1.0	15.6	17.1	16.7	15.8	65.2
10	NNW-2	331	1.7	15.4	17.9	17.6	17.2	68.1
69	NNW-3	339	5.2	15.6	16.9	16.3	15.2	64.0

TABLE H-3

RADIOACTIVITY IN AIR FILTER
PCI/M3 - 0.037 BQ/M3

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GROSS BETA 570	2.00E-03	1.96E-02 (467 / 467) 9.11E-03 - 3.46E-02	PM-2 BF ATHENS AL 10.9 MILES NE	2.07E-02 (52 / 52) 1.18E-02 - 3.34E-02	1.99E-02 (103 / 103) 1.00E-02 - 3.60E-02	
GAMMA SCAN (GELI) 143						
BE-7	2.00E-02	1.04E-01 (117 / 117) 7.00E-02 - 1.44E-01	PM-2 BF ATHENS AL 10.9 MILES NE	1.09E-01 (13 / 13) 7.53E-02 - 1.39E-01	1.01E-01 (26 / 26) 6.59E-02 - 1.41E-01	
BI-214	5.00E-03	1.44E-02 (88 / 117) 5.00E-03 - 5.11E-02	LM-6BF BAKER BOTTOM 3.0 MILES SSW	1.64E-02 (10 / 13) 5.60E-03 - 3.85E-02	1.15E-02 (16 / 26) 5.00E-03 - 2.49E-02	
PB-214	5.00E-03	1.38E-02 (87 / 117) 5.00E-03 - 4.80E-02	LM-6BF BAKER BOTTOM 3.0 MILES SSW	1.69E-02 (9 / 13) 6.90E-03 - 3.53E-02	1.15E-02 (15 / 26) 6.00E-03 - 2.71E-02	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
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Western Area Radiological Laboratory

TABLE H-4

RADIOACTIVITY IN CHARCOAL FILTER
PCI/M3 - 0.037 BQ/M3

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA
Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 570						
BI-214	5.00E-02	6.81E-02 (34 / 467) 5.22E-02 - 1.14E-01	LM1 BF NORTHWEST 1.0 MILE N	7.86E-02 (4 / 52) 5.45E-02 - 1.14E-01	7.11E-02 (10 / 103) 5.24E-02 - 1.45E-01	
I-131	3.00E-02	SEE NOTE 3				
K-40	3.00E-01	3.69E-01 (17 / 467) 3.07E-01 - 6.65E-01	PM-2 BF ATHENS AL 10.9 MILES NE	5.00E-01 (2 / 52) 3.35E-01 - 6.65E-01	3.26E-01 (4 / 103) 3.03E-01 - 3.79E-01	
PB-214	7.00E-02	8.40E-02 (26 / 467) 7.05E-02 - 1.28E-01	LM2 BF NORTH 0.9 MILE NNE	1.10E-01 (1 / 52) 1.10E-01 - 1.10E-01	9.40E-02 (5 / 103) 7.05E-02 - 1.23E-01	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).
Note: 3. The analysis of Charcoal Filters was performed by Gamma Spectroscopy. No I-131 was detected. The LLD for I-131 by Gamma Spectroscopy was 0.03 pCi/cubic meter.

Tennessee Valley Authority
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Western Area Radiological Laboratory

TABLE H-5

RADIOACTIVITY IN SOIL
PCI/GM - 0.037 BQ/G (DRY WEIGHT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA
Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 11						
AC-228	2.50E-01	1.18E+00 (9 / 9) 7.28E-01 - 1.48E+00	LM4 BF TRAILER P 1.7 MILES NNW	1.48E+00 (1 / 1) 1.48E+00 - 1.48E+00	8.11E-01 (2 / 2) 6.28E-01 - 9.95E-01	
BE-7	2.50E-01	9 VALUES < LLD	PM-1 ROGERSVILLE AL 13.8 MILES NW	1 VALUES < LLD	3.30E-01 (1 / 2) 3.30E-01 - 3.30E-01	
BI-212	4.50E-01	1.22E+00 (9 / 9) 7.88E-01 - 1.57E+00	LM-7BF LAKEVIEW 2.1 MILES WEST	1.57E+00 (1 / 1) 1.57E+00 - 1.57E+00	8.92E-01 (2 / 2) 6.72E-01 - 1.11E+00	
BI-214	1.50E-01	1.05E+00 (9 / 9) 7.63E-01 - 1.34E+00	LM4 BF TRAILER P 1.7 MILES NNW	1.34E+00 (1 / 1) 1.34E+00 - 1.34E+00	7.75E-01 (2 / 2) 6.55E-01 - 8.95E-01	
CS-137	3.00E-02	1.62E-01 (9 / 9) 5.86E-02 - 3.68E-01	PM-2 BF ATHENS AL 10.9 MILES NE	3.68E-01 (1 / 1) 3.68E-01 - 3.68E-01	1.09E-01 (2 / 2) 9.61E-02 - 1.22E-01	
K-40	7.50E-01	5.16E+00 (9 / 9) 2.90E+00 - 7.88E+00	LM4 BF TRAILER P 1.7 MILES NNW	7.88E+00 (1 / 1) 7.88E+00 - 7.88E+00	3.53E+00 (2 / 2) 2.95E+00 - 4.11E+00	
PB-212	1.00E-01	1.18E+00 (9 / 9) 7.48E-01 - 1.54E+00	LM-7BF LAKEVIEW 2.1 MILES WEST	1.54E+00 (1 / 1) 1.54E+00 - 1.54E+00	8.06E-01 (2 / 2) 6.40E-01 - 9.72E-01	
PB-214	1.50E-01	1.16E+00 (9 / 9) 8.21E-01 - 1.49E+00	LM4 BF TRAILER P 1.7 MILES NNW	1.49E+00 (1 / 1) 1.49E+00 - 1.49E+00	8.70E-01 (2 / 2) 7.10E-01 - 1.03E+00	
RA-224	7.50E-01	1.24E+00 (6 / 9) 7.53E-01 - 1.56E+00	LM3 BF NORTHEAST 1.0 MILE ENE	1.56E+00 (1 / 1) 1.56E+00 - 1.56E+00	1.13E+00 (1 / 2) 1.13E+00 - 1.13E+00	
RA-226	1.50E-01	1.05E+00 (9 / 9) 7.63E-01 - 1.34E+00	LM4 BF TRAILER P 1.7 MILES NNW	1.34E+00 (1 / 1) 1.34E+00 - 1.34E+00	7.75E-01 (2 / 2) 6.55E-01 - 8.95E-01	
TL-208	6.00E-02	3.79E-01 (9 / 9) 2.21E-01 - 4.87E-01	LM-7BF LAKEVIEW 2.1 MILES WEST	4.87E-01 (1 / 1) 4.87E-01 - 4.87E-01	2.62E-01 (2 / 2) 2.03E-01 - 3.22E-01	
SR 89 11						
	1.60E+00	9 VALUES < LLD			2 VALUES < LLD	
SR 90 11						
	4.00E-01	9 VALUES < LLD			2 VALUES < LLD	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

TABLE H-6

RADIOACTIVITY IN APPLES
PCI/KG - 0.037 BQ/KG (WET WT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 2						
K-40	2.50E+02	7.47E+02 (1 / 1) 7.47E+02 - 7.47E+02	LM-6BF BAKER BOTTOM 3.0 MILES SSW	7.47E+02 (1 / 1) 7.47E+02 - 7.47E+02	8.74E+02 (1 / 1) 8.74E+02 - 8.74E+02	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

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RADIOACTIVITY IN CABBAGE
PCI/KG - 0.037 BQ/KG (WET WT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 2						
K-40	2.50E+02	1.47E+03 (1 / 1) 1.47E+03 - 1.47E+03	LM-6BF BAKER BOTTOM 3.0 MILES SSW	1.47E+03 (1 / 1) 1.47E+03 - 1.47E+03	1.28E+03 (1 / 1) 1.28E+03 - 1.28E+03	

TABLE H-7

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

TABLE H-8

RADIOACTIVITY IN CORN
PCI/KG - 0.037 BQ/KG (WET WT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 2						
K-40	2.50E+02	2.01E+03 (1 / 1) 2.01E+03 - 2.01E+03	LM-6BF BAKER BOTTOM 3.0 MILES SSW	2.01E+03 (1 / 1) 2.01E+03 - 2.01E+03	2.67E+03 (1 / 1) 2.67E+03 - 2.67E+03	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

RADIOACTIVITY IN GREEN BEANS
PCI/KG - 0.037 BQ/KG (WET WT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 2						
K-40	2.50E+02	1.56E+03 (1 / 1) 1.56E+03 - 1.56E+03	LM-6BF BAKER BOTTOM 3.0 MILES SSW	1.56E+03 (1 / 1) 1.56E+03 - 1.56E+03	1.63E+03 (1 / 1) 1.63E+03 - 1.63E+03	

TABLE H-9

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

TABLE H-10

RADIOACTIVITY IN TOMATOES
PCI/KG - 0.037 BQ/KG (WET WT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 2						
BI-214	4.00E+01	5.67E+01 (1 / 1) 5.67E+01 - 5.67E+01	LM4 BF TRAILER P 1.7 MILES NNW	5.67E+01 (1 / 1) 5.67E+01 - 5.67E+01	1 VALUES < LLD	
K-40	2.50E+02	2.33E+03 (1 / 1) 2.33E+03 - 2.33E+03	LM4 BF TRAILER P 1.7 MILES NNW	2.33E+03 (1 / 1) 2.33E+03 - 2.33E+03	2.48E+03 (1 / 1) 2.48E+03 - 2.48E+03	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

TABLE H-11

RADIOACTIVITY IN SURFACE WATER(Total)
PCI/L - 0.037 BQ/L

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GROSS BETA 26						
	1.90E+00	2.84E+00 (11 / 13) 2.31E+00 - 3.81E+00	TRM 293.5	2.84E+00 (11 / 13) 2.31E+00 - 3.81E+00	2.33E+00 (11 / 13) 2.05E+00 - 2.51E+00	
GAMMA SCAN (GELI) 26						
BI-214	2.00E+01	6.53E+01 (1 / 13) 6.53E+01 - 6.53E+01	TRM 293.5	6.53E+01 (1 / 13) 6.53E+01 - 6.53E+01	4.22E+01 (1 / 13) 4.22E+01 - 4.22E+01	
PB-214	2.00E+01	4.67E+01 (1 / 13) 4.67E+01 - 4.67E+01	TRM 293.5	4.67E+01 (1 / 13) 4.67E+01 - 4.67E+01	2.98E+01 (1 / 13) 2.98E+01 - 2.98E+01	
TRITIUM 8						
	3.00E+02	4 VALUES < LLD			4 VALUES < LLD	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

TABLE H-12

RADIOACTIVITY IN PUBLIC WATER(Total)
PCI/L - 0.037 BQ/L

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GROSS BETA 78						
	1.90E+00	2.64E+00 (46 / 65) 1.92E+00 - 1.16E+01	W MOR-E LAWR WAT ATH TRM 286.5	3.42E+00 (10 / 13) 1.93E+00 - 1.16E+01	2.33E+00 (11 / 13) 2.05E+00 - 2.51E+00	
GAMMA SCAN (GELI) 78						
BI-214	2.00E+01	4.85E+01 (6 / 65) 2.20E+01 - 7.66E+01	W MOR-E LAWR WAT ATH TRM 286.5	6.32E+01 (2 / 13) 4.98E+01 - 7.66E+01	4.22E+01 (1 / 13) 4.22E+01 - 4.22E+01	
PB-214	2.00E+01	3.72E+01 (5 / 65) 2.52E+01 - 5.05E+01	W MOR-E LAWR WAT ATH TRM 286.5	4.77E+01 (2 / 13) 4.48E+01 - 5.05E+01	2.98E+01 (1 / 13) 2.98E+01 - 2.98E+01	
TRITIUM 24						
	3.00E+02	20 VALUES < LLD			4 VALUES < LLD	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

RADIOACTIVITY IN WELL WATER(Total)
. PCI/L - 0.037 BQ/L

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 26						
BI-214	2.00E+01	3.63E+01 (2 / 13) 2.07E+01 - 5.20E+01	BFN WELL #6 0.02 MILES W	3.63E+01 (2 / 13) 2.07E+01 - 5.20E+01	1.47E+02 (10 / 13) 2.10E+01 - 4.85E+02	
PB-214	2.00E+01	4.54E+01 (1 / 13) 4.54E+01 - 4.54E+01	BFN WELL #6 0.02 MILES W	4.54E+01 (1 / 13) 4.54E+01 - 4.54E+01	1.28E+02 (12 / 13) 2.01E+01 - 4.90E+02	
TRITIUM 8						
	3.00E+02	4 VALUES < LLD			4 VALUES < LLD	

TABLE H-13

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

RADIOACTIVITY IN COMMERCIAL FISH
PCI/GM - 0.037 BQ/G (DRY WEIGHT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 4						
K-40	4.00E-01	1.31E+01 (2 / 2) 1.29E+01 - 1.34E+01	WHEELER RES TRM 275-349	1.31E+01 (2 / 2) 1.29E+01 - 1.34E+01	1.38E+01 (2 / 2) 1.28E+01 - 1.49E+01	

TABLE H-14

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

TABLE H-15

RADIOACTIVITY IN GAME FISH
PCI/GM - 0.037 BQ/G (DRY WEIGHT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA

Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 4						
BI-214	1.00E-01	2 VALUES < LLD			1.39E-01 (1 / 2) 1.39E-01 - 1.39E-01	
CS-137	3.00E-02	2 VALUES < LLD			3.26E-02 (2 / 2) 3.16E-02 - 3.35E-02	
K-40	4.00E-01	1.51E+01 (2 / 2) 1.51E+01 - 1.51E+01	WHEELER RES TRM 275-349	1.51E+01 (2 / 2) 1.51E+01 - 1.51E+01	1.34E+01 (2 / 2) 1.30E+01 - 1.39E+01	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

Tennessee Valley Authority
Environmental Radiological Monitoring and Instrumentation
Western Area Radiological Laboratory

TABLE H-16

RADIOACTIVITY IN SHORELINE SEDIMENT
PCI/GM - 0.037 BQ/G (DRY WEIGHT)

Name of Facility: BROWNS FERRY NUCLEAR PLANT
Location of Facility: LIMESTONE ALABAMA
Docket Number: 50-259,260,296
Reporting Period: 2004

Type and Total Number of Analysis Performed	Lower Limit of Detection (LLD) See Note 1	Indicator Locations Mean (F) Range See Note 2	Location with Highest Name Distance and Direction	Annual Mean Mean (F) Range See Note 2	Control Locations Mean (F) Range See Note 2	Number of Nonroutine Reported Measurements
GAMMA SCAN (GELI) 6						
AC-228	2.50E-01	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	2.87E-01 (1 / 2) 2.87E-01 - 2.87E-01	
BE-7	2.50E-01	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	2.71E-01 (2 / 2) 2.63E-01 - 2.80E-01	
BI-214	1.50E-01	2.25E-01 (1 / 4) 2.25E-01 - 2.25E-01	MALLARD CREEK REC AR TRM 293.0	2.25E-01 (1 / 2) 2.25E-01 - 2.25E-01	2.66E-01 (2 / 2) 2.28E-01 - 3.05E-01	
K-40	7.50E-01	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	2.25E+00 (2 / 2) 1.79E+00 - 2.71E+00	
PB-212	1.00E-01	1.27E-01 (4 / 4) 1.08E-01 - 1.51E-01	MALLARD CREEK REC AR TRM 293.0	1.39E-01 (2 / 2) 1.28E-01 - 1.51E-01	2.56E-01 (2 / 2) 2.39E-01 - 2.73E-01	
PB-214	1.50E-01	1.91E-01 (2 / 4) 1.68E-01 - 2.13E-01	MALLARD CREEK REC AR TRM 293.0	1.91E-01 (2 / 2) 1.68E-01 - 2.13E-01	2.90E-01 (2 / 2) 2.50E-01 - 3.29E-01	
RA-226	1.50E-01	2.25E-01 (1 / 4) 2.25E-01 - 2.25E-01	MALLARD CREEK REC AR TRM 293.0	2.25E-01 (1 / 2) 2.25E-01 - 2.25E-01	2.66E-01 (2 / 2) 2.28E-01 - 3.05E-01	
TL-208	6.00E-02	4 VALUES < LLD	MALLARD CREEK REC AR TRM 293.0	2 VALUES < LLD	8.04E-02 (2 / 2) 7.53E-02 - 8.54E-02	

Note: 1. Nominal Lower Level of Detection (LLD) as described in Table E - 1
Note: 2. Mean and Range based upon detectable measurements only. Fraction of detectable measurements at specified location is indicated in parentheses (F).

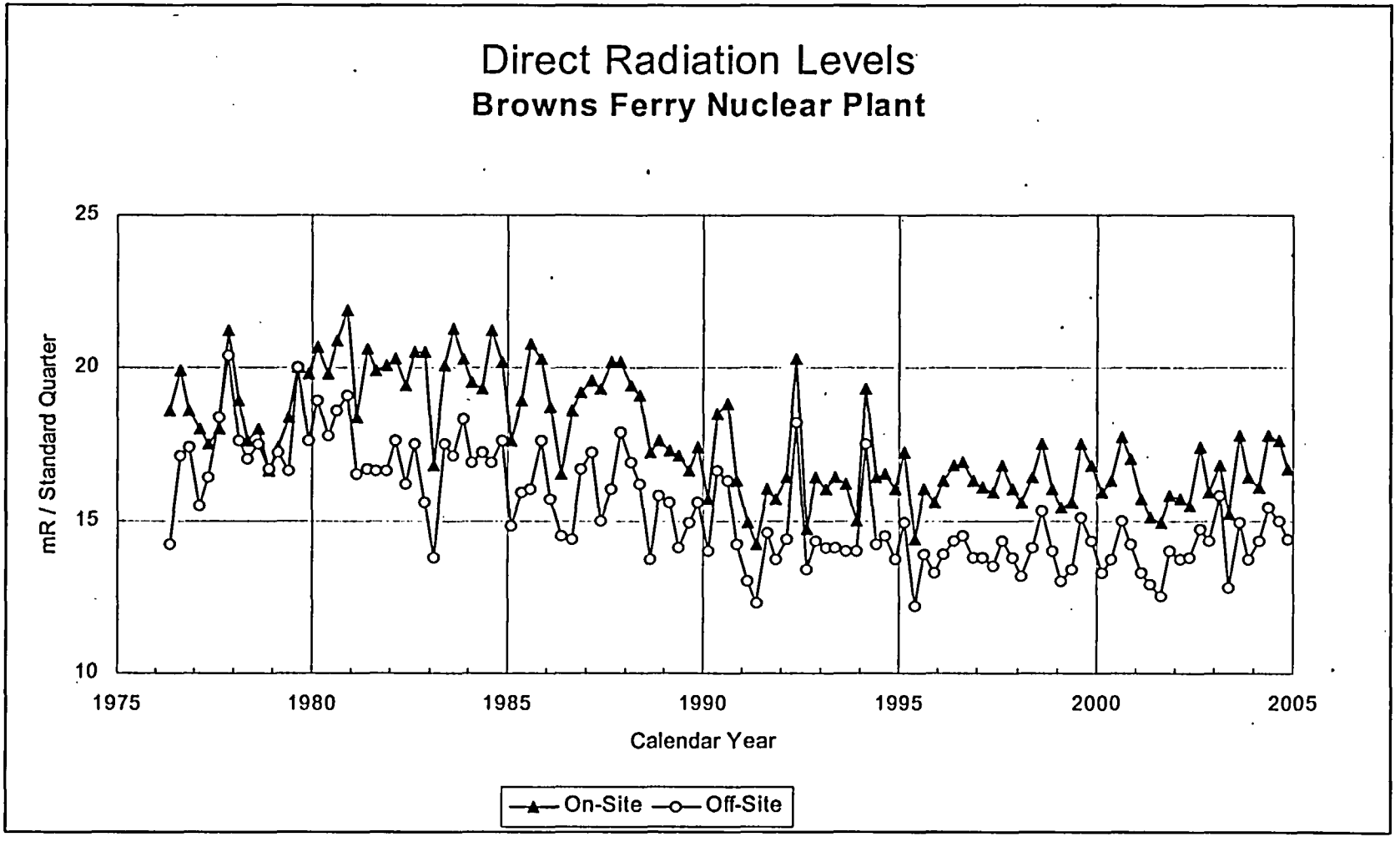
Direct Radiation Levels
Browns Ferry Nuclear Plant
mR / Standard Quarter
25
20
15
10
1975
1980
1985
1990
1995
2000
2005
Calendar Year
On-Site
Off-Site

FIGURE H-1

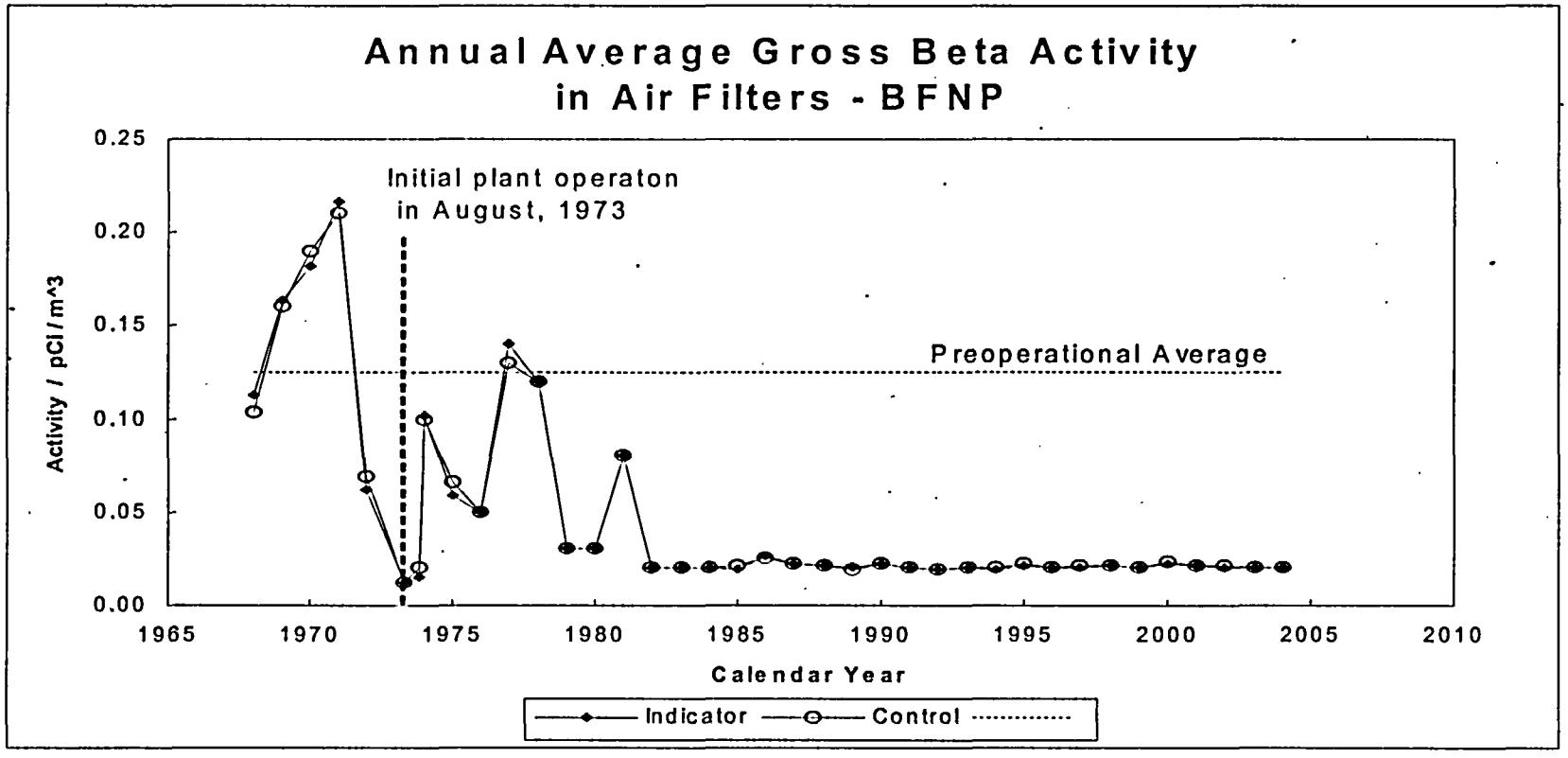
Annual Average Gross Beta Activity
in Air Filters - BFNP
Initial plant operaton
in August, 1973
Preoperational Average
Activity / pCi / m^3
0.25
0.20
0.15
0.10
0.05
0.00
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Calendar Year
Indicator
Control

FIGURE H-2

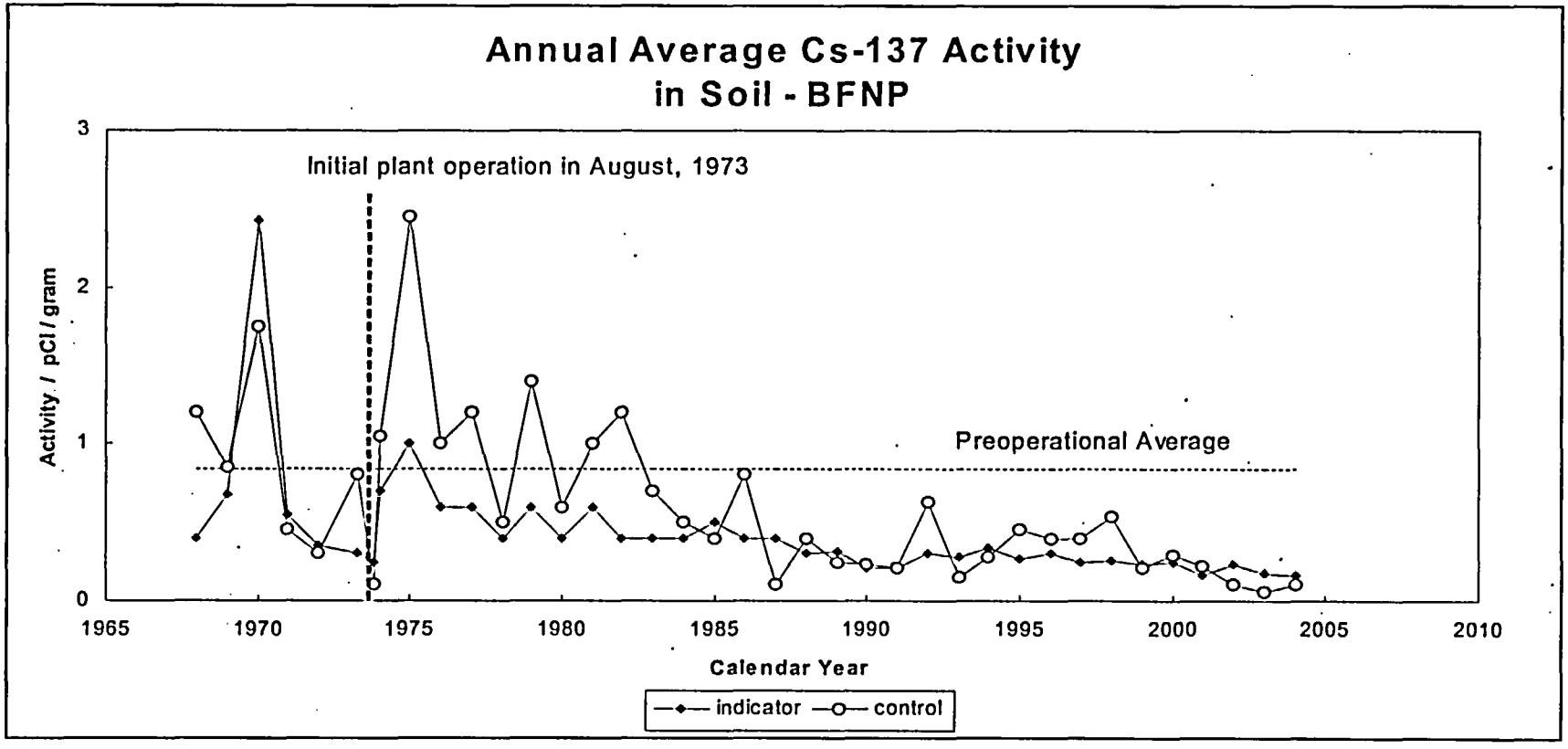
Annual Average Cs-137 Activity
in Soil - BFNP
Initial plant operation in August, 1973
Preoperational Average
Activity / pCi / gram
Calendar Year
indicator
control
0
1
2
3
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

FIGURE H-3

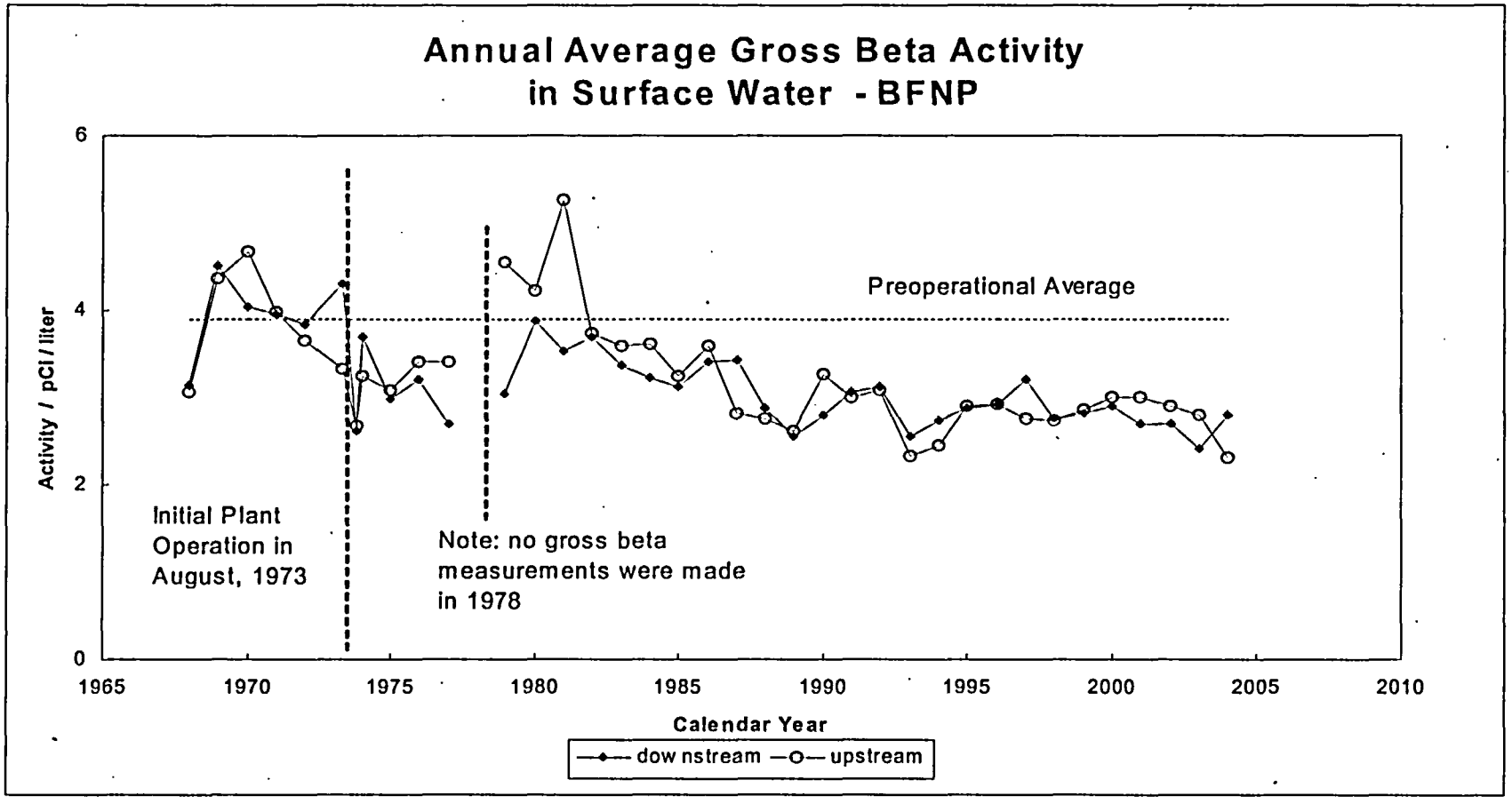
Annual Average Gross Beta Activity
in Surface Water - BFNP
Activity / pCi / liter
6
4
2
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Calendar Year
Preoperational Average
Initial Plant
Operation in
August, 1973
Note: no gross beta
measurements were made
in 1978
downstream
upstream

FIGURE H-4

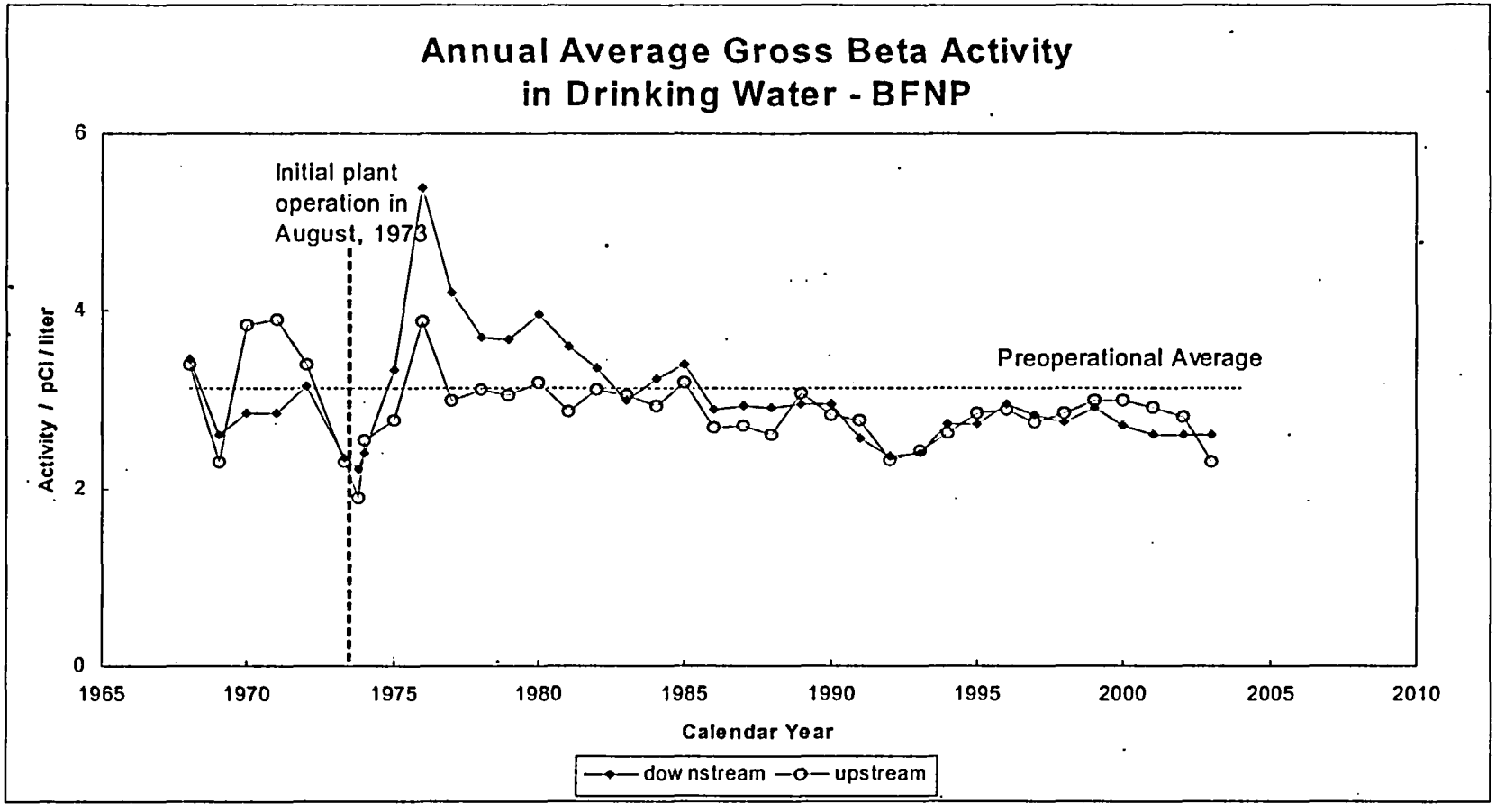
Annual Average Gross Beta Activity
in Drinking Water - BFNP
Initial plant
operation in
August, 1973
Preoperational Average
Activity / pCi / liter
0
2
4
6
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Calendar Year
downstream
upstream

FIGURE H-5

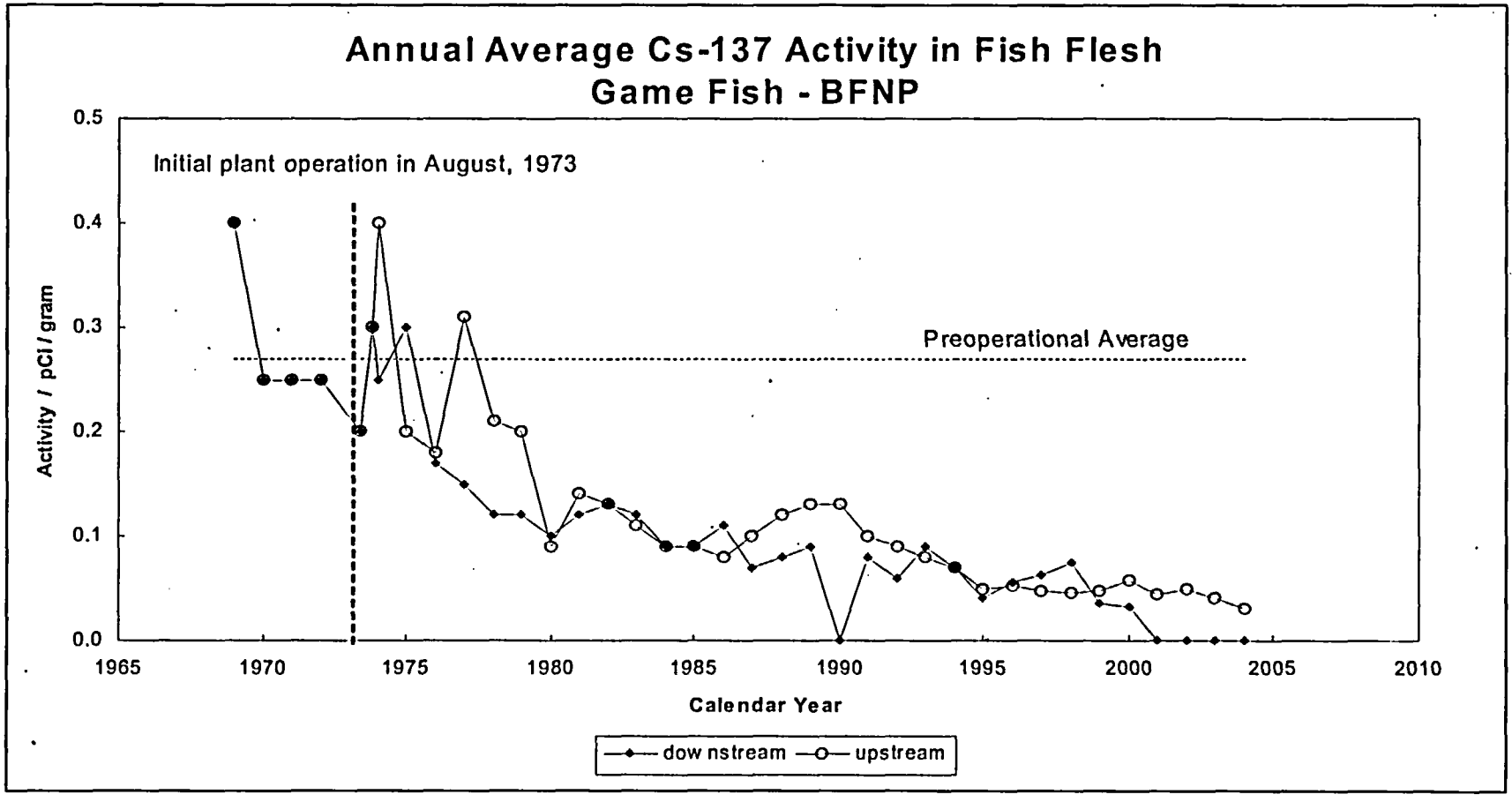
Annual Average Cs-137 Activity in Fish Flesh
Game Fish - BFNP
Initial plant operation in August, 1973
Preoperational Average
Activity / pCi / gram
0.5
0.4
0.3
0.2
0.1
0.0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Calendar Year
downstream
upstream

FIGURE H-6